

Electrochemical and Metallurgical Industry

VOL. V.

NEW YORK, MARCH, 1907.

No. 3.

Electrochemical and Metallurgical Industry

With which is Incorporated Iron and Steel Magazine

Published on the first of each month by the
ELECTROCHEMICAL PUBLISHING COMPANY,
[Incorporated.]

114-118 LIBERTY STREET, NEW YORK.

J. W. RICHARDS, PH. D. President
E. F. ROEBER, PH. D. Editor

Subscription Price: \$2 per year, postpaid to any part of the
world. Single copies 25 cents.

Copyrighted, 1907, by the Electrochemical Publishing Co.

Entered as Second-Class Matter, June, 1906, at the Post-Office at New
York, N. Y., under the Act of Congress, March 3, 1879.

NEW YORK, MARCH, 1907.

CONTENTS.

EDITORIAL	71
Mors Imperatrix	71
Immigrants as Imports.....	71
The Metal Market	72
Utilization of Atmospheric Nitrogen	72
The American Workman	73
Chemists' Building	74
The Iron and Steel Market.....	74
CORRESPONDENCE:	
Electric Smelting for the Foundry. By P. McN. Bennie.....	75
Melting Points. By F. Maeulen.....	76
Fixation of Atmospheric Nitrogen. By G. Erlwein.....	77
Metallurgical Calculations. (Thermal Efficiency of Open-Hearth Furnaces.) By J. W. Richards.....	79
Electrometallurgy of Zinc. By W. McA. Johnson.....	83
Iron and Steel from Black Sands. By D. T. Day and R. H. Richards	85
The Butters Slime-Filter at the Cyanide Plant of the Combination Mines Co. By M. R. Lamb.....	88
The Electric Furnace in the Pottery Industries. By R. S. Hutton.....	90
Electrochemical Problems	92
Electric Steel. (Induction Furnace.) By H. Roechling.....	92
NOTES ON ELECTROCHEMISTRY AND METALLURGY IN GREAT BRITAIN	94
RECENT METALLURGICAL PATENTS	96
SYNOPSIS OF PERIODICAL LITERATURE.....	98
ANALYSIS OF CURRENT ELECTROCHEMICAL PATENTS	102
New Factory Building	105
Slime Concentrator	105
NOTES	106
PERSONAL	108
DIGEST OF UNITED STATES PATENTS. (Carborundum).....	108
NEW BOOKS	109
BOOK REVIEWS:	
Monographs in Applied Electrochemistry, Vols. 18 to 24.....	100
W. R. Ingalls, on Lead Smelting and Refining.....	110
Van Nostrand's Chemical Annual	110
M. Toch, on Mixed Paints.....	111

Mors Imperatrix

During the month of February death has removed three eminent veteran fighters from the front ranks of chemical endeavor and activity: the Russian, Dmitri Ivanovitch Mendeleeff; the Dutchman, Hendrik Willem Bakhuis Roozeboom, and the Frenchman, Henri Moissan. The death of each of these three men has been deeply felt as an international loss to chemistry. Mendeleeff's name will forever be connected with the periodic system of elements for which he built a broad, sound, general, empirical foundation. Roozeboom highly distinguished himself in chemical thermodynamics, in continuing and expanding the work of our late J. Willard Gibbs. As Prof. Bancroft once put it, what was condensed into a few paragraphs by Gibbs has been expanded into the phase rule by Roozeboom, and bids fair to become the basis of classification for the whole of chemical science. Moissan had only recently been honored with the Noble prize for chemistry. He is known personally to many American chemists from two visits to this country. But his life work with the electric furnace is known all over the world wherever there are electrochemists. We hope to publish in our next issue a sketch of his life and work from the pen of one who has the privilege to call Moissan his teacher and master. While we mourn the loss of these three men we know that their work is alive and will be alive. Each of these men opened new avenues for chemical progress. Future generations will harvest the fruit.



Immigrants as Imports

Approximately a million immigrants entered the United States last year. These were a heterogeneous lot as regards race, color and previous condition of cleanliness. They were largely adult males in the prime of life—mostly young men at the age of maximum productivity. They were distinguished by the boldness and the enterprise of the pioneer. The same outcry which was made by the older immigrants and their descendants, that these new ones are the "scum of Europe," was made by the Americans of English descent seventy years ago against the Irish and German immigrants of that period. We thus will dismiss that indictment. Let us then consider the economic value to the nation of these as producing units for the industrial machine. It would cost on the average at least three thousand dollars with interest charges to raise each of these human beings in America. That this is a conservative value can be seen by comparing this figure with the price of black slaves and their productivity in ante-bellum days. Consequently, the net increase of the nation's wealth due to this class of imports, totals the immense sum of three billion dollars per annum, or is about equal to our entire foreign trade,

both exports and imports. This valuation is probably too low. Very little is paid for this importation, but it is simply taken from the older countries by the will of the immigrants. We hope that such of those million as read this will not be offended by being classified as "duty-free" imports. Whoever is, can console himself that America was colonized by immigrants, who came in duty free.



The Metal Markets

The upward swing of the pendulum has carried the price of metals to an undreamed of high level. Copper, due to the immediate causes outlined in our notes on car shortage in our January issue, has risen to full 25 cents, and the copper supplies are so closely held that if large producers so desired copper would go to 28 or 30 cents. Pig iron is selling so high that importations of Scotch iron are being made. Lead is absolutely controlled marketwise by the dominant interests. Silver is low relative to prices before 1893, but has risen nearly 40 per cent over panic prices. There seems to be good reason for looking for a healthy recession. Too high prices curtail consumption and also teach the use of cheaper substitutes to the trades. The capital cost of all new constructions is now charged to succeeding generations at a figure that is so high that the railways and industrial companies wisely are planning to curtail new work. Spelter is selling relatively high, but based on cost of production its price is low as compared with copper, lead and iron. This is due to the fact that the zinc business has not yet been "trustified." Due to high price of lumber, with which galvanized iron competes, and high price of copper with which sheet zinc and galvanized sheets also compete, when the reaction comes hard, spelter is less apt to feel the downward force than other metals.



It would appear that the recession in business—slight though it may now appear, and to some observers only confined to the stock market—is liable to grow greater. First of all, next year is a presidential year, and supersensitive finance discounts all uncertainty a long time in advance. Then too—car shortage and lack of railway facilities, of which Mr. J. J. Hill has spoken so clearly—hamper expansion. Undoubtedly good crops next Summer would diminish the intensity of the reaction. Considering the present high levels of metals in relation to this tendency for business to draw in its horns because of high prices, we would infer that consumption will not increase, or in other words, relatively be decreased, and normal rate of growth be reduced. The near increase of metal production, due to starting up of new metallurgical works, will increase absolutely the production, consequently lower prices for metals during the Winter of the year 1907-1908 seem probable. This will be an unmixed blessing, for growth has been too rapid to be altogether healthy. There is no great apprehension of a real serious panic, but such a slowing down will do us good and allow plans to mature. As the French may say, it is a case of "reculer pour mieux sauter"—to draw back in order to get a running jump. In the long run, no sane man can help but be a bull on American industry.

Utilization of Atmospheric Nitrogen

The free nitrogen gas, which makes up 75 per cent by weight of the atmosphere, is useless in its inert state. Its chief characteristic property is its unwillingness of entering into any combination under ordinary conditions, and to make it useful we must force it into combination. While the numerous practical attempts in this field have been closely followed and discussed in this journal in the past in numerous articles and notes, the paper by Dr. Georg Erlwein, published elsewhere in the present issue, contains much interesting information that is new, and affords a welcome opportunity to comment again on the matter. Dr. Erlwein is the chief engineer of the electrochemical department of the Siemens & Halske Co., and his paper is interesting *per se* as a human document, showing the enormous amount of early research work done by this company along lines completely neglected at that time by others, and emphasizing again the eminent personal qualities of the late Werner Siemens. He conceived the idea that the day would come when agriculture would cease to provide food for the human race, and artificial food would be made in industrial plants. This would be, of course, the natural solution of the social problem of to-day, of which Secretary Shaw recently spoke before the students of the University of Chicago, when he pointed to the number of immigrants which come to this country every year, not to go to the farms, but to the factories—and "the time is coming when manufacturers will outgrow the country." The evolution now going on tends to replace an agricultural State by an industrial State. This economical "reaction" cannot go on to a finish, except the idea of industrially produced artificial food is realized. Otherwise, according to the laws of social economy (which are quite analogous here to those of chemical dynamics), the reaction will stop before it is finished and a state of equilibrium will be reached. The late Werner Siemens, in spite of his highly developed faculty of prophetic imagination, was an eminently practical man. He investigated experimentally the possibilities of artificial food, but his company's larger-scale commercial work in this field tended to the solution of the simpler and nearer problem—the production of fertilizers from the nitrogen of the air. Dr. Erlwein's story of the numerous attempts taken up and given up in succession is an interesting object lesson on the methods by which the former artillery lieutenant, Siemens, starting with nothing but his brains and his energy, succeeded in building up the wonderful industrial structure of the Siemens & Halske Co.



In our issue of last April we gave in an editorial a review of the various possibilities of fixation of atmospheric nitrogen. We will not repeat ourselves if we emphasize in this note some distinct features of only the two processes which have become a commercial success. One, the Birkeland-Eyde process, in use in Norway, produces nitric acid and nitrates direct from atmospheric air by means of electric discharges. The raw product—the atmospheric air—costs nothing. The two chief items of cost are the electric power for the discharges and the cost of concentrating the end product of the electrochemical discharges—a very dilute solution—into a marketable product. To understand the commercial success of the Norwegian plant, it is necessary to consider its extremely low cost of electrical

power, which is given as \$5.00 or less per electric horse-power-year. The other commercially successful process, in use in Italy, produces calcium cyanamide either from calcium carbide and atmospheric nitrogen or from lime, coke and atmospheric nitrogen. Without taking into consideration the cost of lime and coke, it is important to understand that atmospheric nitrogen, not atmospheric air, is here the raw material. In other words, it is first necessary to separate the nitrogen from the oxygen of the air. Thus we have here a considerable item of expense right at the start of the process. On the other hand, the end product—cyanamide—is directly marketable or may be easily worked up into other marketable products. With respect to the latter point, Dr. Erlwein's paper is very suggestive.

* * *

As already noticed there are two methods of making cyanamide. The Erlwein (Siemens & Halske) process starts with lime, coke and nitrogen, and produces directly cyanamide in an electric furnace. In the other process this reaction is resolved into two steps: first, calcium carbide is made in the electric furnace in the ordinary way, and then, according to the method of Frank, the carbide is changed in an atmosphere of nitrogen into cyanamide. As long as the calcium carbide boom with high prices lasted in Europe, the Erlwein process was more profitable. When the boom was over and the carbide prices went down, the Frank process became the cheaper one, and is now used in Italy. An abstract of a research of Carlson in the Synopsis of our present issue seems to indicate that the last word has not yet been spoken as to the best method of making cyanamide. As operated in Italy, the Frank process is a most interesting example of the commercial possibilities of using extreme temperatures. The raw materials are, on one hand, nitrogen, obtained by fractional distillation from liquid air—thus necessitating the lowest temperatures now available—and on the other hand, calcium carbide—the commercial product of the electric furnace with its temperature at the other end of the temperature scale.

—♦♦♦—

The American Workman

There are four factors in the production of wealth—land, capital, labor and management. In our November issue we editorially discussed some of the characteristics of the American capitalist. We may now take up the salient features of the American workingman, with whom the capitalist is so often at variance. First of all, let it be said that in all that makes for social and economic well being, the laborer in the United States, be he skilled or unskilled, has as much as or more than the average middle class in Europe. While his opportunities for pleasure are not so good, yet this is more than counterbalanced by material enjoyments and by the hope and ambition that he and his family can better their station. This is due to the wonderful productivity of American industry in which so large wages are paid because of the widespread use of machinery. The food of our average laborer is of so high a class that his physical strength is great. Often lean and angular, his endurance is wonderful. The American laborer is also resourceful and ingenious, a result of the pioneer

spirit that still exists to-day in the descendants, spiritual as well as physical, of the founders of the republic. The readiness with which the American adapts himself to new conditions is seen in the way in which the large blast furnaces in the metallurgy of copper and iron are handled. The ability to operate expensive machinery at a maximum efficiency is par excellence the cause of high wages. As we have often pointed out, the effect is that the labor charge per ton of product is usually much less in this country of high wages than in countries of low wages, like Italy.

* * *

A further distinguishing trait is the kind treatment that the American workman gives his wife and family. This always strikes the acute foreign observer, and should be a point of pride with all of us. The American always wants his children to have the advantages that he missed. This is as it should be in a nation of self-respecting freemen. In loyalty to the employer the American is not behind the European, though this is less formal than in Europe where the feudal instinct is everywhere manifest. The rise of labor unionism in this country is giving some of us much anxiety, but it is a natural development of the workman, where he feels that his rights are withheld. Should the "ca-canny" spirit pervade America as it has England, it will be a sad day for all of us. Let it be distinctly understood that combination of workmen is an absolute necessity, where the spirit of rapacity is rampant on the other side. But to go to the other extreme and to wrest from capital its rightful return by the aggression and tyranny of labor unions, will put a blight on all industry. However, the labor question looks less serious to us now than it did four years ago, before President Roosevelt took up his active campaign of the "square deal." And we believe that the good sense of the American people, making itself known in forceful public opinion, will tend to minimize the errors of thoughtless and selfish men whether they wear overalls or sit at mahogany desks.

* * *

The American workman is to be criticised in two respects. He is often headstrong and restless in leaving employment, but this only reflects the spirit of twentieth-century America. In the second place too many American workmen are wasteful in their household expenditures, especially in the purchase of foolish nicknacks. This is also due to the crude spirit of eternal youth, especially rampant in the growing West. We have not the slightest doubt that a general system of national postal savings banks would extend the spirit of thrift and savings, so prevalent in careful New England and the other Eastern States, and increase the wealth of the country beyond all measure. The waste of the poor is the curse and cause of their poverty. But considering the American workman in a composite mental photograph, we are rather proud of him. As far as happiness and morality goes he is ahead of his wiser, far-seeing, and avaricious capitalistic friend, but, of course, he does not stop to realize this. If his employer be of the higher type, both give each other full measure of affection, sympathy and loyalty. And these isolated examples of perfect accord between the "boss and his boys" are not growing less, even in these days of monster corporations.

Chemists Building

At a special meeting of the building committee of the Chemists' Club on Jan. 18, the president, Mr. Maximilian Toch, presented the following report as to a new building for the Chemists' Club.

"1. A stock company should be formed whose directors would have exclusive control of the building after erection, and they should enter into a lease on very reasonable terms with the Chemists' Club for such space as it may require for meeting room, library and social purposes. The Chemists' Club shall have the right to sub-let the meeting room under similar conditions as they sub-let rooms now at 108 West Fifty-fifth street, and suitable restrictions should be placed upon the Chemists' Club so that only scientific, musical and kindred societies may become sub-tenants.

"2. This stock company shall be a realty company, which shall be composed of the principal men who have contributed, the president being the chairman of the board, and absolute control of the entire building shall be vested in this board.

"3. The management of the building shall be entirely in the hands of the directors of the realty company. * * * *

"4. Any surplus funds, after the payment of the dividends, should be used for the purpose of outstanding stock of the corporations. * * * *

"5. It shall be the privilege of the Chemists' Club while a tenant of the building to purchase stock at par, the same conditions mentioned in paragraph 3 should obtain."

The building shall be so constructed that there will be at least ten laboratories to let to chemists. There also shall be ten or fifteen sleeping apartments for non-resident members, while the library, which shall be known as the Perkin library, shall have all books, etc., in duplicates, one copy for use at the club, the other for circulating purposes. Further, there will be baths, a bowling alley and a small gymnasium, for all of which a nominal fee will be charged. A large hall with a suitable lecture table will be provided, capable of holding comfortably 500 people.

The Iron and Steel Market.

It is clear that the crest has been passed in the iron and steel trade. The market is on so different a basis than formerly that this statement does not infer what it would have been a few years ago, that prices were becoming weaker and production decreasing. Prices of all finished steel products are as firm as they were a month or two months ago,

steel mills will not buy merchant pig iron to swell their production of crude steel and finished products, to the extent they probably would were it certain that the present orders would be replaced by equally large ones at full prices. The exception is a slight one as to tonnage, but illustrates an important phase of their attitude. There is some profit in furnishing finished steel products made from purchased pig iron, but very much less than in using the steel producer's own material.

It is accepted that railroad buying in the future will be on a materially reduced scale, on account of the difficulty in financing, but the present commitments of the railroads will keep the iron trade at full speed for many months to come. Commitments from interests other than the railroads are proportionately heavier than usual, and their renewal will depend largely upon crop prospects.

The indications thus are, that while the greatest activity should prevail for six or nine months to come, there will be some recession in demand late this year and in 1908. Productive capacity, however, is increasing rapidly.

It taxed the resources of the industry to make 17,821,307 gross tons of pig iron. In the following year, owing to the completion of new furnaces, a much larger tonnage could have been made, but the slump in production in the last quarter of the year brought the total to only 18,009,252 tons. In the following year demand was light and many new furnaces which had been completed were not blown in until about the close of the year, the 1904 production being only 16,497,033 tons. In 1905 the full employment of all capacity resulted in a production of 22,992,380 tons, while 1906 showed 25,307,191 tons. Through the progress of new erection it can be estimated, on quite complete data, that so far as physical considerations control, a production of 28,000,000 tons can be made. With the present trade outlook it is quite certain that no such tonnage can be absorbed, and a reaction in prices of pig iron is inevitable. It does not follow that a reaction in prices of finished steel products is probable, for the double reason that pig iron had reached a level out of all proportion with finished products, and prices of finished steel products are closely held. They were prevented from unduly advancing, and can within limits, be prevented from declining.

The following table represents approximately the production of the absolutely new furnaces blown in, or to be blown in, from Jan. 1, 1905, to July 1, 1907. The furnaces included are all absolutely new ones, with the single exception of a southern furnace, which replaces an old one not in blast since 1903. Many furnaces have been rebuilt, but it is not regarded as feasible or desirable to include them:

PRODUCTION OF NEW BLAST FURNACES,

	Production		During		
	1st Half,	2d Half,	1st Half,	2d Half,	
<i>Blown in during:</i>					
First half, 1905.....	338,000	1905.	487,000	487,000	487,000.
Second half, 1905.....	.....	119,000	256,250	256,250	156,250
First half, 1906.....	.....	.....	185,000	440,000	440,000
Second half, 1906.....	.....	.....	.....	119,000	235,000
First half, 1907.....	.....	.....	.....	.....	490,000
 Totals	338,000	.....	606,000	928,250	1,302,250
Actual production.....	11,163,175	11,829,205	12,582,250	12,724,941	2,120,750

and in some few instances they are higher. If production has decreased at all, the change is of the slightest and has been forced purely by physical conditions. Pig iron prices have eased off a trifle, but considering the prospects for six or nine months to come they are remarkably firm.

The steel producers have an unprecedentedly large volume of business on books, and a very large part of this is in the form of absolute orders and specifications. This business is of the soundest description, and will be filled as fast as physical conditions permit, with the sole exception that the large

The actual increase in production in the second half of 1905 and the first half of 1906 was progressively greater than the contribution of the new furnaces. This was due chiefly to harder driving and the rebuilding and otherwise improving of old furnaces. No such influence was manifest in the second half of 1906. Possibly the limit of hard driving had been reached; certainly weather conditions were especially unfavorable, and an unusually large number of furnaces were out for relining during the third quarter of the year.

The presentation should be conclusive that a very large in-

crease in production is possible over 1906, while trade conditions do not warrant the belief that there will be any material increase in consumptive demand.

PIG IRON.

The Bessemer pig iron is greatly disturbed and the outlook is quite uncertain. A large tonnage regularly goes from merchant furnaces to consumers on contracts which call for monthly adjustment of price, according to the average of sales made in the open market. These contracts contain a clause releasing the consumer from taking the iron should the monthly average pass above \$20. This it did last October by a few cents, while the November average was but a few cents under \$22 and the December and January averages were both \$22.07 f. o. b. valley furnace. In December an adjustment was made with one consumer by the sale of a tonnage at a flat price considerably under the average. In January a round tonnage was released, which was sold to other parties. In February, adjustments were not so easily made and the whole future of such contracts is in doubt. The large steel interests which occasionally buy large tonnages in the open market completely withdrew from the market months ago, but for some time the market advanced through the very heavy purchases of malleable iron foundries and steel foundries. These interests depend largely on the railroads and their interest in the market is now slight, so that the merchant furnaces making steel making pig first, lost their regular customers and are now losing their newer customers. Bessemer pig for second half is held nominally at \$21.50, valley furnace, but some small lots have sold at lower prices and it is purely a matter of conjecture what may be done later on large lots. Southern iron showed a reactionary tendency, but the chief producers have been endeavoring to hold strictly to the old quotation of \$18.50, Birmingham, for second half. There is too little inquiry to test the market. Foundry iron f. o. b., valley furnace, has been nominally \$21.50 for second half, but the market has not been tested. Altogether the demand for pig iron is so stagnant that close quotations cannot be given, and time must fix the new level, if there is to be one, as seems inevitable. Prices cannot for the present precede to former levels as costs to ordinary merchant furnaces are much higher, with the large advances in coke and ore.

STEEL.

The supply has been much better and steel mills have caught up, to a large extent, on old contracts. No billets or sheet bars are offered as originating in Pittsburg, but other steel works, and particularly new interests, have been offering steel at slight concessions. While two months ago Bessemer billets were nominally \$29.50, f. o. b. Pittsburg, and sheet bars \$30, f. o. b. Pittsburg, billets can be had f. o. b. Youngstown or Ohio valley mill at about \$20, f. o. b. mill, and sheet bars at about \$29.50, f. o. b. mill. To most consuming points this means a reduction, although for actual Pittsburg delivery it could hardly be said that there has been a decline.

FINISHED STEEL.

There have been no important changes in prices. Steel boiler tubes have been advanced two points, or about \$4 a net ton, following an advance of one point Jan. 25, and of two points Dec. 20. Independent tin-plate mills are obtaining an advance of 10 cents a box for third quarter deliveries, but the regular price has not changed. At regular mill prices plate deliveries are three months or more behind, steel bars two to three months and sheets two to three months behind. Occasionally premiums are obtained on these lines for early delivery, but in general buyers are so well covered by contracts that business is conducted at the regular mill prices. These are as follows:

Standard rails, 50 pounds and heavier, \$28 at mill; light rails made from new steel, f. o. b. Pittsburg, \$34 on carloads and \$32 on larger lots, sections 25 to 45 pounds.

Structural shapes, \$1.70 for beams and channels, 15 inch and under, angles and zees; \$1.75 for tees; \$1.80 for beams and channels over 15 inch.

Plates, \$1.70 for tank quality, 1/4 inch and heavier, 100 inches wide and less.

Merchant steel bars, \$1.60 base.

Sheets, 28 gauge, black, \$2.60; galvanized, \$3.75.

Tin plates, \$3.90 for 100-pound cokes.

CORRESPONDENCE

Electric Smelting for the Foundry.

To the Editor of Electrochemical and Metallurgical Industry:

SIR:—In the February issue of ELECTROCHEMICAL AND METALLURGICAL INDUSTRY, Dr. Richard Moldenke, the able secretary of the American Foundrymen's Association, writes a letter so full of suggestive hints that I commend it to the attention of every foundry manager. In Dr. Moldenke's letter the whole subject is brought to such a clear, definite focus that foundrymen and others interested in the intensive development of foundry practice may find plenty of food for reflection.

It is likely that the needs of the humble foundry have not had the attention they deserve from those of us who are trying to make a place for the electric furnace in the general metallurgical scheme. Nowadays the "tonnage" bug is very busy among our blast furnace and open-hearth brethren, and it may be we champions of the electric furnace have also fallen victims to the same influence.

Yet I do not think the possibilities of the electric furnace in the foundry have been entirely overlooked, for at a meeting of the Philadelphia Foundrymen's Association, on June 1, 1904, I had the honor of presenting a paper before that body on the "Application of the Electric Furnace to Metallurgy of Iron and Steel."

The paper covered generally the state of the art at that time, finally closing with the following for the benefit of that particular audience:

"In concluding this paper we take the liberty of making some reference to the application of the electric furnace to foundry practice, as being of more immediate interest to you. Take a foundry with a number of cupolas. It would be possible to arrange an electrical refining furnace so that it could use the product of any one, or all of the cupolas. The accompanying illustration (showing a furnace of the Héroult or Keller type) will give an idea of how this could be done, although several types of furnaces shown here could be applied. Here we have a furnace body in the form of a ladle, placed upon a carriage, suitably counter-balanced, and able to swing free in a circle. It may receive its charge and then be placed under the arrangement for carrying the electrodes, as shown. By lowering the electrodes, turning on the current, refining may be carried out as previously described in several processes. Without using excessive currents liquid iron may be converted into steel of good quality.

"This may suggest to some of your enterprising foundry managers ways of employing their full capacity at all times; to improve the quality of their castings; to convert a portion of the product into steel. For a small cost a foundry arranged for the manufacture of cast iron could undertake steel castings, and augment considerably its sphere of commercial activity.

"As to electrical power, many foundries are already equipped. However, in discussing the matter with a well-known central station manager, we were assured that they would welcome any proposition which would take power during their periods of light load, say, from 10 P. M. to 1 P. M. the next day, and could make very low rates for such intermittent power to be taken at definite times. It would enable them to increase their

load factor and also fill up their pocketbooks at the same time." It will be observed, however, that the method suggested above differs somewhat from the one proposed by Dr. Moldenke. I was referring then to a process taking hot metal from some fuel-fired apparatus, and by means of the electric furnace doing sufficient refining to produce steel castings metal.

I think Dr. Moldenke is quite correct in his opinion that for such operations as are purely melting propositions, involving only a minimum amount of refining, the electric induction furnace is worthy of consideration. Given a proper quality of selected scrap it would be a comparatively simple process to turn out a metal very suitable for steel castings.

Until the experiments have actually been made and results studied, I am not prepared to say what economies will be realized. The conditions under which such operations would be conducted would, in many cases, be unique, as pointed out by Dr. Moldenke. For instance, take the case he mentions, where a foundryman finds it necessary in order to get a large contract to bid on a specification including some steel castings. In such cases the foundryman might feel warranted in using the electric furnace to produce his steel casting composition, so long as it cost less than he would have to pay for outside work. The simplicity of the installation would probably appeal to him also. In addition to the great advantage of being able, with the electric furnace, to get the highly fluid metal necessary for fine and intricate castings, there are the further advantages of control of temperature and atmosphere, points of vital importance for high-grade work.

ELECTRIC FURNACES IN BRASS FOUNDRIES.

When considering the use of the electric furnace for melting brass compositions, we come to a problem of quite a different character. The production of brass and allied mixtures is necessarily a *purely melting process*, and for the purpose it seems to me the electric induction furnace is admirably suited. Compared to simple melting of iron the conditions are quite different as to working temperature, resistivity and specific heat of the bath, etc. Yet there is the great advantage in favor of the induction furnace that it approaches very near to the conditions existing in the crucible process of melting brass, and for that reason should give the same superior quality of metal. Superior quality of metal generally means a higher price for the product.

As to the economy of the electric induction furnace compared with other methods, I think our data are as yet too meagre to permit of positive assertions. If we compare the crucible process with the induction furnace process I should say that there is hardly any doubt that brass mixtures can be melted in the induction furnace at less total cost per ton than in crucibles. If we compare the induction furnace with the more modern types of brass melting furnaces, then there is not so much room for fuel economy, if the published figures of 7 to 10 cents per 100 pounds melting cost are taken as a basis.

However, I believe the matter of loss of metal or "shrinkage" is of far greater importance, both as to cost and quality of metal; and in that respect the electric induction furnace possesses advantages quite peculiar to itself. Of course, the shrinkage loss varies greatly with different mixtures, running from 15 per cent down to as low as 2 per cent. If 5 per cent may be taken as a conservative mean, and 10 cents per pound as a fair estimate of value, then it is evident that there is a loss of about 50 cents per 100 pounds to work on.

Theoretically, the electric induction furnace should eliminate such losses to a large extent, by reason of several favorable conditions:

- (1) There are no oxidizing gases playing directly on the bath of metal, as in most modern brass melting appliances.
- (2) The heat is not conducted from some external source, as in crucibles, where the temperature is difficult of adjustment, frequently higher than is wanted and unfavorable to uniform results.
- (3) The heat is generated directly within the mass of metal

itself, and being under perfect control there is no occasion for overheating or loss of any of the constituents of the mixture by reason of lack of control of temperature.

(4) In the induction furnace the atmosphere may be so controlled as to always have reducing conditions, thus avoiding loss of metal by oxidation.

The complete elimination of shrinkage losses, or even a substantial reduction of such losses, offers even greater opportunity for economy than the item of fuel. There is every reason to expect that the induction furnace can be made the "clean, wasteless process" mentioned by Dr. Moldenke.

I do not believe I am committing a breach of confidence by saying that the possibilities of the electric induction furnace in these lines is fully appreciated by those working for its development, and that experiments to prove its value in the lines suggested above are now under way.

P. McN. BENNIE.

FitzGerald & Bennie Laboratories, Niagara Falls, N. Y.

FEB. 23, 1907.

Melting Points.

To the Editor of Electrochemical and Metallurgical Industry:

SIR:—In your February, 1907, issue, on page 48, under "Melting Points of Elements," there is a table of melting points, the elements being arranged according to the periodic system. Under group VIII. there appears:

Ru.	Pd.	Rh.	Ag.
1,900		1,520	962'

While this should read:

Ru.	Rh.	Pd.	Ag.
1,900		1,520	962'

It may be of interest that while Dr. Harker has found the melting point of platinum to be 1,710° C. by methods thoroughly described in the *Proceedings of the Royal Society*, Vol. A76, 1905, the physicists in our Bureau of Standards at Washington have determined the melting point of platinum as 1,730° C.

The minus sign has evidently been omitted in the temperatures given for the solidification of oxygen and fluorine; sulphur should read 444.6 instead of 114° C., and tin 232 instead of 224° C.

In submitting these corrections it is not intended that they cover the whole table, as I am simply quoting from memory.

NEW YORK CITY.

FREDERICK MAEULEN.

[The table on page 48 of our last issue was reproduced by the photographic engraving process from the original table published in the *London Electrician*, to which journal due credit was given. The table is interesting not only on account of its arrangement but because it embodies the results of Dr. Harker's very extended researches in the (British) National Physical Laboratory. We are much obliged to Mr. Maeulen for the corrections given above, but may add that in the meantime some further and quite serious complications have arisen in the matter of establishing a reliable high-temperature scale on account of the publication of researches carried out by L. Holborn and S. Valentiner in the (German) *Reichsanstalt*. They claim that the fundamental former comparisons between the gas-thermometer and the thermocouple scales have not been as reliable as they were assumed to be. They now find 1,780° C. to be the melting point of platinum. This discrepancy is very much more serious than the difference quoted by Mr. Maeulen between the values of Harker and of our Bureau of Standards. The uncertainty of the whole situation is, however, clearly indicated by the fact that the *Reichsanstalt* will not make general official use of the new figures of its own members until the matter has been thoroughly cleared up by further researches.—EDITOR.]

Fixation of Atmospheric] Nitrogen.

The fixation of atmospheric nitrogen and the application of the products thereby obtained was the subject of a very able paper presented some time ago before the Berlin Electrical Society, by Dr. GEORG ERLWEIN, chief engineer of the electrochemical department of the Siemens & Halske Co. The author has been interested in work of this kind for his company for the last sixteen years.

His full paper may be found in the issues of Jan. 10 and 17, 1907, of *Elektrotechnische Zeitschrift* (pages 41 and 62). In the introduction some preliminary researches are briefly mentioned which were made by Werner von Siemens in 1889 in collaboration with A. W. von Hoffmann; further investigations by O. Frölich and G. Erlwein on the electric production of ammonium nitrate (German patent 85,103 of 1894). Neither of these investigations led to an industrial success, although both had been undertaken, not purely for research purposes, but with an industrial end in view.

The author then mentioned briefly the researches of Crookes and Lord Rayleigh, Bradley and Lovejoy, Birkeland, Kowalsky, Pauling, all of which have been fully covered in our columns. The author also named the following chemical

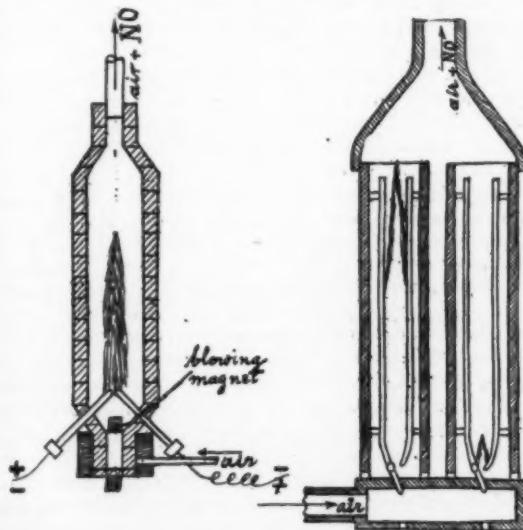


FIG. 1.—SIEMENS DEVICES FOR FIXATION OF ATMOSPHERIC NITROGEN.

manufacturing companies as having been or being interested in work of this nature: Salpetersäure Industrie Gesellschaft in Gelsenkirchen, Westdeutsche Thomasphosphat-Werke, Badische Anilin-und Soda-fabrik in Ludwigshafen.

Siemens & Halske took up the problem again in 1902. The starting point of their new researches was the experience which they had gained in the development of the flame arc lamp, in which the arc carbons are impregnated with certain salts, among them, salts of rare earths and fluorspar. When these salts evaporate into the arc the arc is lengthened and its zone of reaction becomes more effective. Under proper conditions of the experiment, including a blowing magnet acting on the arc and increasing its surface, the effect becomes surprising. The left-hand diagram of Fig. 1 shows the principle of the arrangement used by Siemens & Halske in 1902. In a cylindrical space supplied with compressed air, an arc is produced between impregnated thick carbon electrodes or cooled metallic electrodes and the surface of this arc is greatly increased by the use of a blowing magnet.

Later on, in 1904, a second method was tried by Siemens & Halske, based on the action of the horn lightning arrester so

well known in Europe. The horn lightning arrester consists of two vertical horns, the lower ends of which are near together, while upwards the two horns diverge from each other more and more. The arc is formed, of course, between the two lower ends which are near together. It automatically travels upwards, is thereby enlarged in surface and is finally automatically broken. On this principle the discharge apparatus is based, shown at the right hand of Fig. 1. Between parallel or diverging vertical electrodes, which have a length of several meters and which are placed in closed porcelain or clay tubes, arcs are started at the bottom, which then travel upwards, continually increasing their surface and finally are broken, the speed being easily adjustable. Neither of these two methods has yet been developed into an industrial process which would be sufficiently cheap.

Some notes were given by the author on the efficiency of various systems employing electric discharges through air, and it was said that even with the best efficiencies now obtained, only 3 per cent of the electrical energy are utilized for the oxidation of the nitrogen or the formation of nitric acid proper, while the balance of 97 per cent is consumed mainly by heating the gases required for the reaction as well as the excess of air.

As to the commercial importance which may be attained in future by processes using electric discharges through air, Dr. Erlwein thinks we can give a definite answer only after the lapse of some more years.

A second group of processes is based on the facts known since Wöhler and Deville, that certain metals and metalloids, like silicon and boron, when heated with nitrogen, form nitrides and that these nitrides when treated with steam, again decompose with evolution of ammonia. Technical experiments in this direction on a larger scale have been made by Marguerite, Sourdeval, Mond and Solvay, and also by Friedrich Siemens who worked together with Dr. Obach on this subject at the end of the seventies in Dresden. Siemens' first experiments were not very encouraging, but they were useful in so far as they decided several questionable points.

The Siemens & Halske Co. took these researches up again in 1897 in connection with Dr. Mehner and Director Schlüter, of the Westdeutsche Thomasphosphat-Werke and later with the Gold-und Silber-Scheideanstalt in Frankfurt. Instead of boron nitride (employed in the original experiments) the nitrogen-compounds of sodium were employed, in the first place cyanides. These cyanides in the new experiments were equivalent to the nitrides in the older experiments in so far as they were not intended to be the final product, but were to be decomposed with overheated steam to yield ammonia.

In the old empty Grabau aluminium factory in Trotha, where a 500-hp. steam dynamo was available, a process was tried for considerable time, which had been patented by Dr. Mehner for manufacture of cyanide and ammonia. The process was based on older work of Mond. The results obtained were, however, not sufficiently promising from a commercial point of view. Cylindrical furnaces of 6 meters height and 1 meter diameter were used, which were charged with sodium carbonate and coke. By means of generator gas as source of nitrogen, it was intended to produce first cyanides and to decompose them then at a suitable place of the furnace by treatment with overheated steam so as to get ammonia. In the latter reaction sodium carbonate would be regenerated and was to be used over again together with coke for a new charge of the furnace. The gases of reaction which would be generated during the whole process, and which contained a very high percentage of carbon monoxide, were intended to be used in gas engines after the ammonia had been recovered in scrubbers.

A third group of processes is related to the manufacture of calcium carbide. The outcome of the work in this direction is the manufacture of calcium cyanamide, which is now commercially successful on a large scale. Dr. Erlwein gave an

historical review of the development of the process, mentioning the names Frank, Caro, Rothe, Pfleger, Freudenberg, Frank, Jr., Wagner, Gerlach, Erlwein. The Gold-und Silberscheideanstalt of Frankfurt (the leader of the cyanide syndicate) was first associated with Siemens & Halske in this work, but dropped out later on account of the weak cyanide market at the time of the Boer War. Siemens & Halske then decided not to interest themselves any longer at that time in the production of cyanide from cyanamide,* but to stop with the production of cyanamide and to sell it for fertilizing purposes.

Concerning the principles of making calcium cyanamide

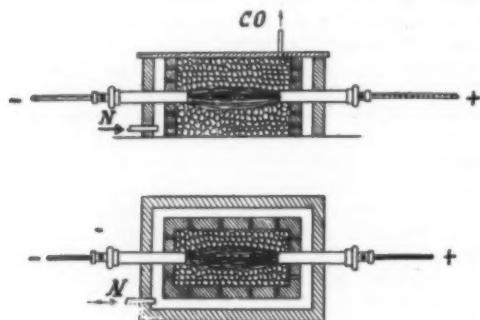


FIG. 2.—CYANAMIDE FURNACE.

either from calcium carbide and nitrogen (Frank-Caro process), or from lime, coke and nitrogen (Erlwein or Siemens-Halske process), reference must be made to former descriptions in our columns (for instance, our Vol. I., p. 423; Vol. IV., pp. 136, 327). The description of the furnaces, given in Dr. Erlwein's paper, appears to contain, however, information hitherto unpublished.

The Erlwein process with lime, coke and nitrogen as raw materials and employing the reaction $\text{CaO} + 2\text{C} + 2\text{N} = \text{CaCN}_2 + \text{CO}$ was first cheaper than the Frank process, starting with carbide and nitrogen, as long as the carbide was high in price. The Erlwein process was carried out in electric fur-

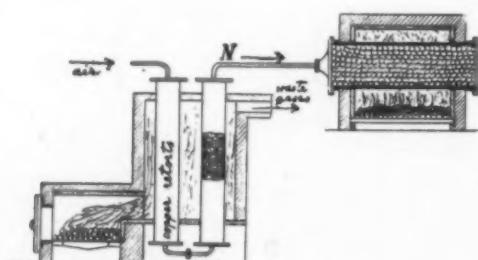


FIG. 3.—CYANAMIDE FURNACE.

naces of the form indicated in Fig. 2, similar to the Acheson type of furnace. They were 6 meters long, 3 meters wide and 3 meters high and had double walls so that the nitrogen could be introduced under pressure into the furnace. An exit was provided for the carbon monoxide gas.

Between the ends of the thick carbon electrodes a thin carbon rod was inserted. When the reaction started, this thin carbon rod first became incandescent and calcium cyanamide formed in concentric layers around it. After completion of the run the cyanamide could be removed in form of a porous cylinder.

When this process had been developed, the excessive calcium

* Dr. Erlwein states that the process of changing the cyanamide into cyanide has been fully worked out, and will soon be the basis of a new cyanide undertaking, since the cyanide market is now in a much better condition.

carbide boom in Europe had led to the inevitable crash and the price of carbide had fallen very essentially. Now it was found that the Frank process, starting with carbide, was the cheaper one and it was developed to a commercial success, as noted in our Vol. IV., p. 327. Its fundamental reaction is $\text{CaC}_2 + \text{N}_2 = \text{CaCN}_2 + \text{C}$.

The most important apparatus for the cyanamide process are those for making pure nitrogen from air and the cyanamide furnaces. To make pure nitrogen from air, either retorts containing copper (see the left half of Fig. 3) may be used, or the atmospheric air may first be liquified by the Linde process by means of strong pressure and cooling down to -194° C . and the liquid air then separated into nitrogen and oxygen by fractional distillation in apparatus of the kind used in alcohol stills.

The principle of the construction of the cyanamide furnaces is shown in the right half of Fig. 3. In the flame room of a coal-fired furnace* retorts are placed, closed air-tight and filled with powdered carbide to a certain height. They are heated to red or white heat and nitrogen gas is introduced into the furnace. Under these conditions the carbide eagerly absorbs the nitrogen; this is an exothermic process and the heat evolved accelerates the reaction. When the gasometer in the gas-supply pipe shows that the carbide does no longer absorb nitrogen, the incandescent cyanamide is removed from the retorts, cooled under absence of air, powdered and packed for shipping.

The cost of making calcium cyanamide depends on the cost of making pure nitrogen from air and on the price of calcium carbide, which is again determined by the price of the electric power. Carbide factories which pay \$10 to \$12.50 per hp.-year and pay otherwise "normal" prices for lime, coke and electrodes and "average wages," "may be sure to make a good profit by working their carbide into cyanamide, even if the price per kg. of nitrogen in the competing Chili saltpetre or ammonium sulphate (which is 37.5 and 32.5 cents, respectively, at present), drops considerably below the present market price. They are especially enabled to make profits if they have at the same time cheap power for operating a Linde plant, which, according to the size of the apparatus and according to the cost of power of 0.5 to 0.75 cents per kw.-hour, is able to produce pure nitrogen from air in continuous operation for 0.75 to 1.25 cents per cubic meter.

"Since modern and well-conducted carbide factories produce about 2 tons of carbide per kw.-year, and since 2 tons of carbide absorb about 500 kg. of nitrogen to form cyanamide, the fixation of 1 ton of nitrogen requires an expenditure of power of two kw.-years. This figure is interesting if compared with the energy required for binding 1 ton of nitrogen by processes using electric discharges through air for the purpose of making nitric acid, where even with the best efficiencies about 6.4 kw.-years are required."

The commercial calcium cyanamide (Kalk-Stickstoff) is a black powder, stable in air and consists of about 57 per cent of calcium cyanamide, 14 per cent of free carbon (which gives the black color), 21 per cent caustic lime, 2.5 per cent of silicic acid, 4 per cent of iron oxide and small quantities of sulphur, phosphorus and carbonic acid. The average content of nitrogen is 20 per cent.

When put into water, calcium cyanamide dissolves, but decomposes quickly (especially in hot water) yielding caustic lime, and, with polymerisation, a complicated compound called dicyanamide.

When treated with overheated steam, calcium cyanamide gives off its nitrogen quantitatively in form of ammonia.

Treated with acids in aqueous solution a number of highly interesting organic compounds are obtained under certain conditions. Among these products is urea.

When melted with sodium carbonate, sodium chloride, or other materials, the whole nitrogen in the cyanamide is

* There is, therefore, nothing electrical whatever about this whole process, except the manufacture of the carbide.

changed into cyanide-nitrogen and the product when cooled consists of a mixture of calcium cyanide, sodium cyanide and the products of the decomposition of the added material.

Dr. Erlwein finally discusses briefly the practical applications of calcium cyanamide.

1. Cyanamide may be used directly as a fertilizer in agriculture. Those who are interested in the agricultural side of the problem will find interesting comparative pictures of the growth of plants under the fertilizing action of Chili salt-petre and calcium cyanamide, etc., in the original German paper.

2. Calcium cyanamide may be used for the production of ammonium sulphate, which is also consumed in large quantities for fertilizing purposes. The reaction yielding ammonia is $\text{CaCN}_2 + 3\text{H}_2\text{O} = \text{CaCO}_3 + 2\text{NH}_3$. The apparatus used for carrying out this reaction is shown in Fig. 4. It may be useful to provide such ammonium-sulphate factories as an addition to cyanamide factories in order to take care of the over-production.

3. Cyanamide may be used for the manufacture of dicyandiamide, a compound used in the manufacture of aniline colors and gun powder. By suitable leaching with water and crystallization, this compound is obtained in form of pretty white crystals. The chemical equation is



4. Cyanamide may be used as starting material for the

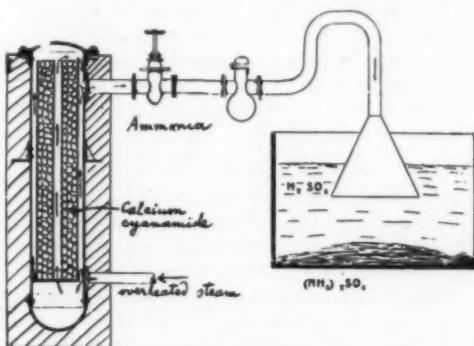


FIG. 4.—PRODUCTION OF AMMONIUM SULPHATE.

commercial manufacture of sodium cyanide or potassium cyanide. According to a process devised by Freudenberg, the calcium cyanamide is melted with sodium chloride in excess and is thereby transformed almost completely into sodium cyanide. The product obtained in this way, which contains about 22 to 23 per cent of sodium cyanide (corresponding to 30 per cent of potassium cyanide) is either sold directly in this form as so-called "sodium-cyanide substitute" (Cyannatrium-Surrogat) for use in gold metallurgy or is worked up into chemically pure sodium cyanide or potassium cyanide. Both brands will be made on a commercial scale as soon as a new factory is completed which is in course of erection near Berlin.

5. As a hardening material for iron and steel, calcium cyanamide has found a new sphere of application. This application is due to the ability of cyanamide to give off carbon to the iron which is thereby hardened. This ability is enhanced by the addition of other compounds to the cyanamide and this product is now sold under the trade name of "Ferrodur." Dr. Reininger, chief chemist of the well-known tool-steel and machine works of Ludwig Loewe, first recognized this property of cyanamide and called attention to the extremely uniform action of this new hardening material, which proves useful especially at such temperatures at which a uniform introduction of carbon into iron heretofore met with difficulties.

6. For the manufacture of urea a small plant is already in operation in which the calcium cyanamide is treated in a suitable way with acids and immediately changed into solutions of urea, which may be easily crystallized.

Metallurgical Calculations.

By J. W. RICHARDS, PH. D.

Professor of Metallurgy in Lehigh University.

THERMAL EFFICIENCY OF OPEN-HEARTH FURNACES.

The ordinary open-hearth steel furnace receives cold pig iron, cold scrap, warm ferro-manganese, cold limestone and cold ore, it receives cold air and moderately warm producer gas, and it furnishes melted steel and slag at the tapping heat. The larger part of the usefully applied heat is that contained in the melted steel, for it must be melted in order to be cast, and when once taken away from the furnace the latter is done with it.

The total heat available for the purposes of the furnace and which should be charged against it consists of the following items:

- (1) Heat in warm or hot charges.
- (2) Heat in warm or hot gas as it reaches the furnace.
- (3) Heat in warm or hot air as it reaches the furnace.
- (4) Heat which could be generated by complete combustion of the gas.
- (5) Heat of oxidation of those constituents of the charge which are oxidized in the furnace.
- (6) Heat of formation of the slag.

The items of distribution of this total will be as follows:

- (1) Heat in the melted steel at tapping.
- (2) Heat absorbed in reducing iron from iron ore.
- (3) Heat absorbed in decomposing limestone added for flux.
- (4) Heat absorbed in evaporating any moisture in the charges.

These first four items constitute the usefully applied heat, and their sum measures the net thermal efficiency of the furnace.

- (5) Heat absorbed in reducing ferric oxide to ferrous oxide.
- (6) Heat in the slag.
- (7) Heat lost by imperfect combustion.
- (8) Heat in the chimney gases as they leave the furnace.
- (9) Heat absorbed by cooling water.
- (10) Heat lost by conduction to the ground.
- (11) Heat lost by conduction to the air.
- (12) Heat lost by radiation.

(1) HEAT IN WARM CHARGES.

If the pig iron is charged melted instead of cold an immense amount of thermal work is spared the furnace, and it should be charged with all the heat (reckoning from 0° C. as a base line) which is in the melted pig iron as it runs into the furnace. This will average 275 Calories per unit of pig iron, but should be actually determined calorimetrically in each specific instance wherever possible. The net thermal efficiency of the furnace will figure out higher with cold charges than with melted pig iron, because, with a possible flame temperature of 1,900° C. in the furnace, heat is absorbed much more rapidly by cold charges than by hot ones, and a larger percentage of the available heat will be thus usefully applied.

Scrap is almost always charged cold, but if any of it is hot its weight and temperature should be known and the amount of heat thus brought in charged against the furnace. Or a small piece may be dropped into a calorimeter and its heat content per unit of weight measured directly, and thus the heat in all the hot scrap used may be estimated.

Ferro-manganese is often added cold, but usually is pre-heated to cherry redness (about 900°) in another small furnace, in order that it may dissolve more quickly in the bath. Knowing its weight, temperature and specific heat, the heat which it brings into the furnace can be calculated; a better plan is to drop a piece into a calorimeter and measure the actual heat in a sample of it.

Limestone and ore are almost invariably put into the furnace cold. If used warm the heat in them can be determined by the methods just described.

(2) HEAT IN THE GAS USED.

By this is meant, not the heat in the gas after it is heated by the regenerators, but its sensible heat as it reaches the furnace. This applies only to furnaces where the producers or gas supply are independent of the furnace. Where the producers are an integral part of the furnace it is impracticable to consider them separately from the furnace, and the efficiency of the whole plant, including the producers, must be considered together. But where the gas supply from whatever source comes to the furnace from outside, and reaches the furnace warm, its sensible heat is to be charged against the furnace as part of the heat which the furnace must account for. If the gas comes from producers its amount is satisfactorily found from the known weight of carbon gasified per hour, or per furnace charge, and the weight of carbon contained in unit volume of gas, as calculated from its analysis. If gas comes from a common main which supplies several furnaces, or is simply natural gas, its amount can only be roughly estimated by measuring the area of the gas supply pipe or flue and measuring the velocity of flow by a pressure gauge or Pitot tube or anemometer. None of these methods just mentioned are satisfactorily accurate, and there is great need of simple methods for determining accurately the flow of gases in flues or pipes. If the velocity of warm gas is determined suitable correction for its temperature must be made to reduce it to volume at standard conditions.

(3) HEAT IN THE AIR USED.

If the air coming to the furnace is warm its sensible heat must be charged against the furnace. If the air is warmed, however, before it goes into the regenerators by waste heat from the furnace itself, then its sensible heat should not be charged against the furnace, because that would amount to charging the furnace twice with this quantity of heat. Such preheating is in reality only a part of the regenerative principle, even though it may not be done in regenerators, but, for instance, by circulating air around a slag-pot or through the hollow walls of the furnace. If the air used is moist its moisture should not be omitted in the calculation.

The amount of air used is best determined by a comparison of the analyses of gas and chimney products, and a calculation based on the carbon contents of each and the known volume of gas used.

(4) HEAT OF COMBUSTION.

Under this head comes the principal item of heat available for the furnace. In reckoning it we should calculate the total heat which could be generated by the perfect combustion of the gas used, to CO^2 , N^2 and H^2O vapor. If there is in reality imperfect combustion, as is shown by analysis of the chimney gases, that is a defect of operation of the furnace which should be written down against it. Problem 68 showed an actual case in which there was very incomplete combustion in the body of the furnace, but where combustion was afterwards completed in the regenerators. In such a case the same principle applies; the furnace must be charged with the total calorific power of the fuel used, and incomplete combustion can be charged against the furnace as a whole only on the basis of unconsumed ingredients in the chimney gases—the products finally rejected by the furnace. If there is poor combustion in the body of the furnace and combustion is only completed in the regenerators, the furnace will not give as high net thermal efficiency as if combustion were complete above the hearth.

(5) OXIDATION OF THE BATH.

The oxidation of carbon, iron, silicon, manganese and sometimes phosphorus and sulphur, add a not inconsiderable amount to the heat resources of the furnace. Carbon should be burnt to CO^2 , iron is usually oxidized to FeO , manganese to

MnO , silicon to SiO^2 , phosphorus to P^2O^5 , and sulphur to SO^2 . All of these oxidations generate heat, and, moreover, heat which should be very efficiently utilized, being produced in direct contact with the metallic bath; it should all be charged against the furnace as part of its available heat.

(6) FORMATION OF SLAG.

The metallic oxides produced unite with each other, and with the lime and silica of ore used and lining of the hearth to produce the slag, the heat of formation of which can be calculated and counted in as available heat.

(1) HEAT IN MELTED STEEL.

This is a large item in the work done by the furnace; in fact, usually the largest single item. It should be determined calorimetrically when possible; if this is not done its temperature should be known and its composition, in order to compare it with the calorimetric experiments of others, and thus derive a probable value for its heat contents. Not many experimental values in this line have so far been published, and a very much needed investigation is one upon the total heat in melted steels of different compositions at different temperatures. Values from 275 to 350 Calories per kilogram have been observed.

(2) HEAT OF REDUCTION OF IRON FROM ORE.

This is an item which appears whenever ore is used to facilitate oxidation of the bath. The weight and composition of the charges and the products will easily show how much iron has been reduced. The ore used is almost always hematite, less frequently magnetite; hydrated iron oxides are not used for obvious reasons. The heat absorbed is 1,746 Calories per kilogram of iron reduced from Fe^3O^4 and 1,612 Calories per kilogram from Fe^2O^3 .

(3) DECOMPOSITION OF LIMESTONE FLUX.

If limestone is charged raw, as is usually done in order to avoid the dusting caused by using burnt lime, then the furnace is called upon to burn this limestone in place of the lime kiln. The heat absorbed may be taken as either

451 Calories per kilogram of $CaCO^3$ decomposed.

1,026 Calories per kilogram of CO^2 driven off.

806 Calories per kilogram of CaO produced.

(4) EVAPORATION OF MOISTURE IN THE CHARGES.

If the ore, flux, scrap or ore are put into the furnace wet their moisture must be evaporated. The correct figure for this evaporation is the latent heat at ordinary temperatures, viz.: 606.5 Calories per kilogram. This allows for the heat required to convert into cold vapor of water, and puts the H^2O thereafter upon the same basis as all the other gas going out of the furnace. The chimney gases carry out sensible heat, and the H^2O in them can be calculated as carrying out a certain amount of heat as gas, reckoning from zero, and thus the correct chimney loss obtained. It is incorrect either to charge the latent heat of vaporization as chimney loss or to charge the sensible heat of the water vapor in the chimney gases to heat absorbed in evaporating water in the furnace. It is also incorrect to do as is frequently done, viz.: to calculate the heat required to evaporate the moisture to water vapor at 100°—637 Calories—and say that this is the heat to evaporate the moisture. With almost no moisture in the gases, the moisture of the charges would commence to evaporate at once, while they were yet cold, and the moisture is no more evaporated at 100° or to vapor at 100° than it is to 200° or 500°. The only safe course is to confine the evaporation heat to that necessary to convert the moisture into cold vapor, and let its sensible heat as it escapes as vapor at any other temperature be reckoned in with the sensible heat of the chimney gases.

(5) REDUCTION OF ORE INTO THE SLAG.

While considerable of the iron in the ore used is reduced to the metallic state, yet often the larger part is reduced merely

to the state of FeO , and as such goes into the slag. The amount so reduced can be determined by subtracting the iron reduced from ore from the total iron in the ore used; the difference gives the iron from the ore going into the slag as FeO . The weight of FeO corresponding is then easily calculated. The heat absorbed in this partial reduction is:

446 Calories per kilogram of FeO reduced from Fe^3O^4 .
341 Calories per kilogram of FeO reduced from Fe^3O^4 .

(6). HEAT IN SLAG.

This is usually a small item in open-hearth practice, but may amount to a very considerable one in the method of running with large ore charges, as in the Monell process. The variations of composition of the slag, and especially in the temperature at which it is run off, are so large that the heat in the slag should always be determined calorimetrically for each specific case. If assumptions have to be made, 450 to 550 Calories per kilogram of slag would be assumed. The weight of slag is seldom taken, although it could in most cases be done if desired. If the weight is not known it may be calculated from the known weight of either iron, manganese or phosphorus going into it, as seen from the balance sheet, and the percentages of these elements in the slag as shown by analysis.

(7) LOSS BY IMPERFECT COMBUSTION.

This is based upon the unconsumed ingredients of the chimney gases, as shown in an analysis. From this the calorific power of the unburnt gases in 1 cubic meter can be calculated. If then we know the volume of chimney gases per unit of charge, we get the heat loss by imperfect combustion per unit of charge. The volume of chimney gas is found by means of the carbon in it, which must all come from the carbon in the gas used, plus the carbon oxidized out of the charges, plus the carbon of CO^2 , driven off raw limestone used as flux. Or, putting it in another way, the total carbon going into the furnace in any form, less the carbon in finished steel, must give the carbon in the chimney gases. This divided by the weight of carbon in unit volume of chimney gas gives the volume of the latter, per whatever unit of charge is used as the basis of calculations. This volume times the calorific power of unit volume of chimney gas, gives the total heat lost by imperfect combustion.

(8) SENSIBLE HEAT OF CHIMNEY GASES.

The temperature of these gases should be taken as they enter the chimney flue. Their amount is determined as explained under the previous heading. The water vapor contained should not be overlooked, being reckoned simply as vapor or gas in exactly the same category as the other gases. The analysis of the chimney gases being usually given on dried gas, a separate determination of the moisture carried per unit volume of such dried gas is necessary. If this is not done an approximation can be made by considering all the hydrogen in the gas burned to form water vapor, and add in the moisture of the air used and the moisture in the charges.

(9) HEAT LOST IN COOLING WATER.

This is a very variable amount, and must be determined for each furnace by measuring the amount of water used per unit of time and its temperature before reaching and after leaving the furnace. Doors are frequently water-cooled, also ports, where the heat is fiercest, and sometimes a ring around the hearth at the slag line.

(10) LOSS BY CONDUCTION TO THE GROUND.

This is a quantity extremely difficult to measure or to estimate. If a closed vessel filled with water were put into the foundations the rate at which its temperature rose might give some idea of the rate at which heat passed in that direction per unit of surface contact. At present, lacking all reliable data, we must put this item in the "by difference" class.

(11) LOSS BY CONDUCTION TO THE AIR.

This is an amount which can be observed and calculated with some approach to satisfaction. The *sina qua non* for this purpose is a Fèry radiation pyrometer, by which the temperature of the outside of the furnace at different parts can be accurately determined. Then the velocity of the air blowing against the furnace, if it is in a current of air, is observed with a wind gauge, and its temperature before reaching the furnace. With these data and by the methods of calculation before explained in these calculations (March, 1906) the heat lost to the air may be calculated.

(12) RADIATION LOSS.

Having determined the temperature of the outer surface of the furnace and measured its extent, as above explained, the radiation loss can also be calculated, knowing the mean temperature of the surroundings, by the principles of radiation, having due regard to the nature of the radiating surface. Tables of specific radiation capacity of different substances (fire-brick, stone, iron) will be found at the reference just given above.

Problem 69.

Jüptner and Toldt (Generatoren und Martinöfen, p. 73) observed the following data with regard to an open-hearth steel furnace charge:

Weight of cold charges, at 26° C.....	3,745 kg.
Weight of hot charges, at 700° C.....	1,700 "
Total weight of charge.....	5,445 "
Average composition of charge.....	C = 1.07 per cent
	Si = 0.50 "
	Mn = 1.33 "
Coal gasified in producers.....	1,980 kg.
Carbon gasified from coal.....	47.13 per cent
Average composition of dried gas used....	CO ² 3.81 "
	O ² 0.98 "
	CO 23.82 "
	CH ⁴ 0.42 "
	H ² 8.75 "
	N ² 62.22 "
Moisture accompanying each m ³ of gas.... =	82 grams
Temperature of gas reaching furnace.....	165° C.
Temperature of air used.....	26° C.
Moisture accompanying each m ³ of air.....	12 grams
Barometer	717 m. m.
Steel produced	5,191 kg.
Composition of Steel.....	C = 0.12 per cent
	Si = 0.04 "
	Mn = 0.19 "
Temperature of steel when tapped.....	14.10° C.
Heat in 1 kg. steel, by calorimeter (to 0° C.).	277 Cal.
Composition of slag.....	SiO ² 45.65 per cent
	FeO 33.60 "
	MnO 18.21 "
	CaO 2.54 "
Weight of slag.....	425 kg.
Temperature of slag when issuing.....	1,410° C.
Heat in 1 kg. slag, by calorimeter (to 0°).....	560 Cal.
Composition of the stack gases (dry)....	CO ² 11.12 per cent
	O ² 6.78 "
	N ² 82.10 "
Temperature of the gases in chimney flue.....	500° C.

Requirements:

- (1) A balance sheet of materials entering and leaving the furnace.
- (2) A balance sheet of the heat available and its distribution.
- (3) What excess of air above what is necessary for complete combustion is used, and what per cent of all the available heat of the furnace is thereby lost?

(4) What is the thermal efficiency of the furnace?
 Solution: (1)

BALANCE SHEET OF MATERIALS.				
Charges.	Steel.	Slag.	Gases.	
Metal,	5,445 kg.			
C,	58 "	6	...	52
Si,	27 "	2	25	...
Mn,	72 "	10	62	...
Fe	5,288 "	5,173	115	...
Limestone,	20 "			
CaO,	11 "	...	11	...
C,	2.5 "	...	...	2.5
O,	6.5 "	...	...	6.5
Hearth,				
SiO ²	132 "	...	132	...
Gas,	7,884 "			
C,	933 "	...	933	
O,	2,003 "	...	2,003	
H,	118 "	...	118	
N,	4,830 "	...	4,830	
Air,	16,026 "			
O,	3,812 "	80	3,732	
N,	12,195 "	...	12,195	
H,	19 "	...	17	
Totals,	29,507 "	5,191	425	23,891

NOTES ON THE BALANCE SHEET.

The distribution of carbon, silicon, manganese and iron is governed by the known amounts of these elements present in the steel, the rest of the carbon going into the gases (as CO²), and the manganese, silicon and iron passing into the slag (as MnO, SiO² and FeO, respectively).

The amount of limestone used was not stated, but was deduced from the fact that the slag was said to weigh 425 kilos. and to contain 2.54 per cent of CaO, which makes the CaO 11 kilos., and assuming pure limestone, this would bring in 9 kilos. of CO², which appears on the balance sheet as 2.5 kilos. of carbon and 6.5 kilos. of oxygen, contributed to the gases.

The weight of silica contributed by the hearth is deduced from the fact that the slag must contain the silicon, manganese and iron oxidized from the charge, as SiO², MnO and FeO, the CaO of the flux and the SiO² contributed by the hearth, and its total weight is 425 kilos. The ingredients of the slag must, therefore, be

	Kg.
SiO ²	25 × 60/28 = 53.5
MnO	62 × 71/55 = 80.0
FeO	115 × 72/56 = 147.9
CaO	= 11.0
Sum	293
From hearth (difference)	132
Total slag	425

The gas used we find by starting with the fact that 1,980 kilos of coal is used, from which 47.13 per cent of carbon enters the gases. This makes carbon in the gases 933 kilos. Each cubic meter of dry gas, as analyzed, contains 0.2805 cubic meter of CO², CO and CH⁴ added together, and, therefore, 0.2805 × 0.54 = 0.1515 kilos of carbon. The volume of dry producer gas used is therefore, at standard conditions, 933 ÷ 0.1515 = 6,160 cubic meters, containing by its analysis:

CO ²	6,160 × 0.0381 = 235 m ³ = 465 kg.
O ²	" × 0.0098 = 60 m ³ = 86 "
CO	" × 0.2382 = 1,467 m ³ = 1,840 "
CH ⁴	" × 0.0042 = 26 m ³ = 19 "
H ²	" × 0.0875 = 539 m ³ = 49 "
N ²	" × 0.6222 = 3,833 m ³ = 4,830 "
	6,160 m ³ = 7,297 "

The moisture is 82 grams per each cubic meter of gas, measured at 26° and 717 m.m. pressure; but the 6,160 cubic meters of gas at standard conditions would be 7,175 cubic meters at those conditions of temperature and pressure, and therefore be accompanied by

$$7,175 \times 82 = 588,350 \text{ grams}$$

$$= 588 \text{ kg. of H}_2\text{O vapor.}$$

We can now enter the gas on the balance sheet either as so much CO², CO, H₂O, etc., or else resolve it into its essential constituents C, H, O and N, which course we have followed on the balance sheet. The carbon in the gas is 933 kg. by assumption; the oxygen is 8/11 the CO², all the O², 4/7 the CO and 8/9 the H₂O, a total amounting to 2,003 kilos; the hydrogen is 4/16 the CH⁴, all the H² and 1/9 the H₂O, a total of 118 kilos.

The air supplied is best found from the volume of the chimney gases. The total carbon entering these is 52 + 2.5 + 933 = 987.5 kilos., as seen from the balance sheet. Each cubic meter of dry chimney gas contains 0.1112 m³ of CO², carrying 0.1112 × 0.54 = 0.0600 kilos. of carbon. The volume of dry chimney gas at standard conditions is therefore 987.5 ÷ 0.0600 = 16,458 m³. This contains 16,458 × 0.8210 = 13,512 m³ of N², and since 3,833 cubic meters came in with the gas 9,679 m³ must have come in with the air, corresponding to 12,220 m³ of dry air at standard conditions. This would consist of 12,195 kilos. of N² and 3,660 kilos. of O². To find the moisture present the volume of this air at 26° and 717 m.m. pressure would be 14,230 m³, and would be therefore accompanied by

$$14,230 \times 12 = 170,760 \text{ grams}$$

$$= 171 \text{ kg. of H}_2\text{O.}$$

This consists of 19 kilos. of hydrogen and 152 kilos. of oxygen, the latter increasing the total oxygen in the air used to 3,660 + 152 = 3,812 kilos.

(a) HEAT BALANCE SHEET.

Heat Available.	Cal.	Per- centages.
Heat in the warm charges.....	189,210	= 2.45
Sensible heat of air used.....	90,480	= 1.29
Sensible heat of gas used.....	360,550	= 4.68
Heat of combustion of gas.....	6,202,300	= 80.44
Heat of oxidation of the bath.....	833,600	= 10.81
Heat of formation of slag.....	24,200	= 0.31
Total	7,709,340	= 100.00

Heat Distribution.	Cal.	Per- centages.
In melted steel at tapping.....	1,437,900	= 18.65
Decomposition of limestone.....	9,200	= 0.12
Sensible heat of slag.....	238,000	= 3.09
Sensible heat of chimney gases.....	3,118,450	= 40.45
All other losses, not classified.....	2,905,790	= 37.69
Total	7,709,340	= 100.00

Notes on the Heat Balance Sheet.

The warmed charges weighed 1,700 kilos at 700°, and the cold charges 3,745 kilos. at 26°. Taking 0° C. as the base line the sensible heat in these is

Cal.
1,700 × 0.15 × 700 = 178,500
3,745 × 0.11 × 26 = 10,710
Sum = 189,210

The air used contains, at standard conditions, 12,220 m³ of air and 171 ÷ 0.81 = 211 m³ of water vapor. These carry, at 26°, heat as follows:

Cal.
12,220 × 0.3037 × 26 = 98,490
211 × 0.3439 × 26 = 990
Sum = 99,480

The gas used, coming in at 165° C., carries in heat as follows:

	Cal.
O ² , CO, H ² , N ² 5,899 m ³ × 0.3075 =	1,814
CO ² 235 m ³ × 0.4063 =	95
CH ⁴ 26 m ³ × 0.4163 =	11
H ² O 726 m ³ × 0.3648 =	265

Average calorific capacity per 1° =	2,185
Heat content 2,185 × 165 =	360,525

The heat of combustion is that of the combustible ingredients of the gas used to CO² and H²O vapor:

	Cal.
CO 1,467 m ³ × 3,062 =	4,492,000
CH ⁴ 26 m ³ × 8,598 =	223,500
H ² 539 m ³ × 2,613 =	1,486,800

$$\text{Sum} = 6,202,300$$

The heat of oxidation of the bath is from the various substances oxidized:

	Cal.
C to CO ² 52 × 8,100 =	421,200
Si to SiO ² 25 × 7,000 =	175,000
Mn to MnO 62 × 1,653 =	102,500
Fe to FeO 115 × 1,173 =	134,900

$$\text{Sum} = 833,600$$

The heat of formation of the slag is the heat of combination of 80 kilos. of MnO, 148 kilos of FeO and 11 kilos. of CaO, with 186 kilos of SiO². This will be, since the bases are largely in excess of the silica:

$$186 \times 130 = 24,200 \text{ Cal.}$$

The figure 130 is an average for the heat of combination of 1 kilo. of SiO² with about 2 parts of FeO to 1 part MnO.

The heat in the steel at tapping is simply its weight multiplied by its heat contents per kilo. (5,191 × 277).

The heat in the slag is similarly obtained (425 × 560).

The decomposition of limestone represents 9 kilos. of CO² liberated, and the heat absorbed is 9 × 1,026.

The sensible heat in the chimney gases is obtained by first noting that their volume (measured dry), as already obtained, is 16,458 cubic meters. The CO², 11.12 per cent, becomes, therefore, 1,843 m³; the O², 1,116 m³; N², 13,512 m³, while the H²O accompanying this will be 9 times the weight of hydrogen passing into the gases, which is 9 × (118 + 17) = 1,215 kilos. = 1,500 m³. A simpler way to get the volume of the water vapor is to observe that it is always equal to the volume of hydrogen going into it, and, therefore, in this case would be (118 + 17) ÷ 0.09 = 1,500 m³. The heat carried out by these gases would therefore be:

N ² + O ² = 14,628 m ³ × 0.3165 =	4,629.8 Cal. per 1°
CO ² = 1,843 m ³ × 0.4800 =	984.4 " "
H ² O = 1,500 m ³ × 0.4150 =	622.5 " "
Calorific capacity =	623.9 " "
Total capacity =	3,118,450 " " 500°

The heat balance sheet as a whole discloses the fact that in this furnace the fuel only supplies some 80.5 per cent of the total heat available, and that about 10.8 per cent is furnished by the oxidation of the bath itself. On the other hand, the melted steel accounts for 18.6 per cent, while chemical reactions absorb almost none, giving a net thermal efficiency of slightly under 10 per cent. The other important items are 40.5 per cent of the total heat lost up the chimney, and 38 per cent lost by radiation and conduction. Such data as these point the way to avenues of possible saving or avoidance of waste of heat.

(3) The excess of air is obtained directly from the chimney gases. The 1,116 m³ of oxygen, unused, represents 1,116

÷ 20.8 = 5,365 m³ of air in excess, which leaves 16,458 — 5,365 = 11,093 m³ of air which came in and was used. The percentage of air used in excess of that which was necessary was:

$$5,365 ÷ 11,093 = 0.4845 = 48.5 \text{ per cent.} \quad (3)$$

No properly run open-hearth regenerative gas furnace should ever have such a large excess of air, for it cuts down the temperature of the flame and leads to high chimney losses.

The air used brought in 171 kilos of water vapor, and therefore the excess air brought in

$$171 \times \frac{48.5}{148.5} = 56 \text{ kilos. of water,}$$

the volume of which, at standard conditions, would be

$$56 ÷ 0.81 = 61 \text{ cubic meters.}$$

The excess air, with its accompanying water, going into the chimney at 500°, carried out heat as follows:

	Cal.
5,365 × 0.3165 × 500 =	849,000
61 × 0.4150 × 500 =	12,650

$$861,650$$

Representing 861,650 ÷ 7,709,340 = 0.112 = 11.2 per cent. (3)

(4) The thermal efficiency has been already added up as

$$18.65 + 0.12 = 18.77 \text{ per cent.} \quad (4)$$

Electrometallurgy of Zinc.

At a meeting of the New York section of the American Electrochemical Society, held on Jan. 30 at the Chemists' Club (Prof. Sam. A. Tucker in the chair), Mr. WOOLSEY McALPINE JOHNSON, metallurgist of the Tri-Bullion Smelting & Development Co., presented a very interesting paper on the electrometallurgy of zinc, reviewing the attempts made in recent years to treat zinc ores by electrometallurgical means, both in ore-dressing, by electrolytic processes and by the electric furnace.

This development has had the great effect of stimulating new work in the metallurgy of complex sulphide ores of lead, copper, zinc, and by advance in the methods of concentrating zinc ores it has opened up mines, once valueless, into producers and profit-makers.

Electrostatic and Electromagnetic Separators.—Of the three electrostatic separators which have been fairly successful in experimental work—the Huff-Dolbear, the Sutton-Steele and the Blake-Morscher—one, the Blake-Morscher has become a commercial machine (see our Vol. III., p. 181). Sulphides with a metallic lustre are, in general, conductors of electricity. The only mineral sulphide of any importance which is not a conductor is "resin jack," the sulphide of zinc. For this reason electrostatic separation is possible of resin jack from iron pyrites. Separation by water concentration would not be possible on account of the specific gravities being close together.

Among industrial electromagnetic separators the Wetherill, the Ding, the Cleveland-Knowles and the "International" are best known.

The Wetherill separator was developed at the Franklin Furnace mines of the New Jersey Zinc Co., where, after a preliminary water concentration the ore is dried and the magnetic franklinite (a compound of zinc oxide, iron oxide, and manganese oxide) is separated by Wetherill machines from the willemite, the anhydrous silicate of zinc. (Concerning the further treatment of these products, see our Vol. IV., p. 89).

In the West the electromagnetic separator is used in two ways: First, to separate the magnetic oxy-sulphide of iron made by roasting the ore at a low temperature; second, to treat the ore directly for the elimination of the magnetic sul-

phide of zinc and iron, called marmatite. The product which contains 38 to 44 per cent of zinc is well suitable for the spelter furnace. This method is carried out at the Empire Zinc Works, in Carson City, Col., and also at the Rowe Mill of the American Zinc Extraction Co., of Leadville.

A rather complex treatment of Leadville ore is used by the Colorado Zinc Co., at Denver. The ore is crushed and sized on "King" screens. It is then passed over Wilfley tables yielding (a) silicious tailings, (b) zinc-iron middlings, and (c) lead concentrates. The silicious tailings are rejected, while the lead concentrates go to a lead plant. The zinc-iron middlings are dried and passed over a Wetherill electromagnetic machine where the magnetic black-jack is eliminated and sold to a spelter plant as a zinc ore. The non-magnetic product is treated by Blake-Morscher electrostatic separators, producing an iron product low in zinc, and a zinc product suitable for the spelter plant. If the previous magnetic treatment were not inserted, the iron product from the Blake separators would be high in zinc and thus unsuitable for a flux for the lead smelter, and, besides, loss in zinc would be heavy.

The other electromagnetic concentration process is used most largely in the Wisconsin zinc field, which, just on this account, has developed so rapidly as a zinc producer. The concentrates produced here often contain more than 56 per cent zinc. This method will undoubtedly be used in the Rocky Mountain States for the treatment of complex sulphides.

Electrolytic Processes.—In passing over to a review of electrolytic processes of zinc production, Mr. Johnson first dealt with processes designed for the decomposition of the chlorides of lead and zinc in fused condition. He sketched the Swinburne-Ashcroft process (see our Vol. I., p. 413, II., p. 404, and III., p. 63, as well as the series of articles by Mr. Ashcroft in our Vol. IV.), but he thinks that the process has to meet considerable difficulties, mostly due to its complicated nature. Especially the separation of copper, iron and manganese in the wet way might be troublesome. Mr. Johnson believes that the process "will not produce a metallurgical revolution, though it may find a niche in the art of zinc smelting."

Mr. Johnson then mentioned briefly the very similar work done by Messrs. Baker and Burwell, in Cleveland, Ohio, and in Montana (our vol. III., p. 154; Vol. IV., p. 193; Vol. V., p. 56), but thinks it unlikely that this process will ever reach a practical basis. Besides, it has small novelty, being subsequent to the Swinburne-Ashcroft work.

Of wet electrolytic processes Mr. Johnson mentioned that of the late Dr. Hoepfner (see, for instance, our Vol. I., pp. 540 and 568), using hydrochloric acid as solvent. But the leaching of the zinc is imperfect. Gelatinous silica is formed, which is most troublesome to filter press. Much iron is dissolved, which adds to the expense of the plant and cost of treatment.

Nevertheless the Hoepfner process is commercially used by the Brunner-Mond Co. to a small extent, because it enables them to use a by-product and to produce a much higher grade of zinc, which sells in a limited way at a price much above the market price of the average grade of spelter.

Leaching of the roasted ore with alkaline solvents, on the other hand, with the production of alkaline plumbate and zincates is considered by Mr. Johnson to be more promising. The iron oxide is, of course, not dissolved and the silica problem is of a less troublesome nature. The "differential electrolysis," by which lead is deposited at a low potential and zinc at a higher potential, presents difficulties, as does the chemical engineering of this problem. But compared with the Hoepfner process and the Swinburne-Ashcroft proposition, Mr. Johnson thinks this method is distinctly promising.

Electric Furnace Developments.—In passing over to this subject, Mr. Johnson came out with the flat-foot statement that the use of the electric furnace in zinc metallurgy is apparently extremely attractive. Granted electric power from a water-power station at \$12 to \$20 per hp.-year, capital invested per ton of spelter produced per year would be small. An

electric resistance furnace treating zinc ore will put through an enormous tonnage per cubic foot of active space.

The labor charge, high in the present spelter plant, will be low in a continuous electric zinc furnace. As the heats in a good electric zinc furnace are under good control, the recovery of metal will be high. The corrosive nature of certain zinc ores will not be a disturbing factor, for the furnace may be lined with suitable refractory material so that certain ores which are not now available may be used.

The spelter made will be pure, and as it is made in large amounts it will be of uniform purity—quite the reverse of spelter made in the present small retorts. The thermal efficiency of the furnace is high. Eighty-five per cent can be safely counted on in a 500-kw. furnace. Finally there will be a better recovery of lead, silver, copper and gold values.

If, instead of an hydro-electric plant, gas engines should be used, driving electric generators, with a combined efficiency of 23 per cent, the total thermal efficiency of such a zinc works may be assumed to be .85 by 23 per cent, or about 19.5 per cent, which is much more than the present thermal efficiency of 4 to 6 per cent in American practice, and 8 to 10 per cent in good Belgian and German practice (although it may be hoped that in American practice the European figures will soon be reached).

Mr. Johnson then pointed out that in the old retort furnace as used at present, the thermal efficiency is fairly high at the start of the operation, and low at the end. As a rough figure in the Kansas natural gas plants, two-thirds of the spelter is made with one-third of the fuel. This suggested to Mr. Johnson a combination process in which a "preheater" was to perform the first and easy part of the work in form of a regenerative gas furnace with retorts, which would then discharge its partially reduced charge into an electric furnace where the finishing reduction was performed by the more effective but the more expensive heat of the electric current. While Mr. Johnson agreed that this method involved great mechanical and metallurgical difficulties, he stated that he had solved them absolutely on a small scale.

Mr. Johnson has, however, given up this line of work for the present, since the ores of the Kelley mine, owned by the Tri-Bullion Smelting & Development Co. (with which he is now connected), are high in zinc, and are susceptible to treatment by the old process at a large profit compared with the treatment of the ores of competing mines. For these reasons the Traylor Engineering Co., which is erecting the zinc plant for the Kelley mine, considered it much better business not to attempt at once any radically new departure, but to stick to old, tried methods of concentration and reduction with most up-to-date modern apparatus.

The chief trouble from a metallurgical standpoint with the electric zinc furnace is to condense the zinc vapor on a large scale to metallic zinc and not to zinc dust or blue powder. This trouble is directly due to the difficulty of maintaining the proper uniform temperature relations during condensing on a large scale. But these difficulties are certainly not insurmountable. Mr. Johnson also called attention to the great danger to attendants, due to the fact that zinc and carbon oxide at 800° C. are extremely explosive.

Mr. Johnson then referred to the work of Brown and Oesterle, who experimented with a resistance furnace, endeavoring to produce zinc from unroasted ore and to produce at the same time calcium carbide (see our Vol. III., p. 378).

Mr. F. T. Snyder (see also our Vol. IV., pp. 152 and 503), has attempted to reduce in the Siemens electric furnace zinc-lead ores, producing a slag carrying the earthy impurities, metallic lead collecting the gold and silver, and metallic zinc in the condenser of his furnace. Even if there are difficulties in condensing, Snyder may condense his zinc vapor, not to spelter directly, but to blue powder, which may then be treated in the old-fashioned retort like a high-grade zinc ore. Mr. Johnson thinks very well of the process.

Mr. Gustav De Laval (see also our Vol. I., p. 425, and Vol. II., p. 423), has worked his electric furnace on zinc skimmings from the galvanizer or on low-grade "leady" spelter (94 per cent zinc). He produces a high-grade spelter (analyses of which were given on page 54 of our Vol. III.). He has now modified his ore process and uses a reaction something similar to the reaction used on the Wetherill grate of the New Jersey Zinc Co. The roasted ore and coal are blown into the furnace in a whirl and the lighter products are drawn off from the sides, while the heavier are drawn off in the center. Thus, De Laval uses centrifugal force (so characteristic of his other engineering work) in this furnace. De Laval uses this high-grade zinc oxide (70 to 80 per cent zinc) in his electric furnace for the production of spelter.

In this connection, Mr. Johnson remarked that the Wetherill process could be used, if modified rightly, for the same purpose. The New Jersey Zinc Company in fact, does this to some extent. The zinc oxide formed mixed with coal may be reduced to metallic zinc in the old-fashioned retort.

Possibilities of the Old Zinc Retort.—At the conclusion of his paper Mr. Johnson remarked that the old retort has certain definite limitations prescribed by the nature of fire clay; on the other hand, it has certain lines of possible development. Mr. Johnson expressed himself greatly in favor of larger retorts. He also favors mechanical charging. Finally he expressed his conviction that electrical methods will be used largely in the future in the concentration of complex sulphides and in the reduction of the resulting zinc concentrates to spelter—which is one of the widest and most fascinating fields in the domain of metallurgy.

Iron and Steel from Black Sands.

The United States Geological Survey has just issued a report of 84 pages, by Dr. DAVID T. DAY, chief of Division of Mining and Mineral Resources of the Geological Survey, and Prof. R. H. RICHARDS, of the Massachusetts Institute of Technology, on Black Sands of the Pacific Slope in 1905.

In this report the expression "black sands" is used to embrace the residual sands left in concentrating placer gravels. Usually they denote the heavy materials left in the sluice boxes in placer mining, but they include also both the black sands left by the concentrating action of waves and the natural concentration products of stream action. They consist principally of minerals with a specific gravity above 3; and, although the expression "heavy sands" would be more appropriate, they are, as a rule, darker in color than the gravel from which they are obtained, and the expression "black sands" has become general.

The United States Geological Survey was authorized by Congress in 1905, to investigate the useful minerals which are contained in, and could be won from the blacks sands.

In the beginning of the investigation a circular letter was sent to all the placer miners of the United States whose addresses were known, some 8,000 in all, authorizing them to send in samples of the black sands obtained by them, up to 4 pounds for each sample. The examination of these samples, partly in Boston, Mass., and partly in Portland, Ore., showed that the following minerals, in the order named, are most commonly found in these sands: Magnetite, gold, ilmenite, garnet, zircon, hematite, chromite, platinum, iridosmium, mercury, amalgam, olivine, and iron silicates, pyrite, monazite, copper, cinnabar, cassiterite, and corundum. Other heavy minerals are only exceptionally found. The largest field of platinum, and the most profitable field for commercial exploitation, is comprised in Coos, Jackson, Curry and Josephine Counties, Ore., and in Del Norte, Siskiyou, Humboldt and Trinity Counties, Calif.

In an extended study of concentration methods it was found that with careful sizing it is possible to separate gold and platinum from these sands with comparative ease and with

small expense by use of concentrating machines of the shaking-table class, and partial separation of various other minerals can be made at the same time, so as to render available for the market at a low cost monazite, zircon, ilmenite, chromite, garnet and cassiterite. It was also found that the magnetite contained in the black sands of the Pacific slope constitutes a greater supply of useful iron ore than any other available source known on the Pacific slope. This magnetite usually contains from 5 to 10 per cent of titanium. "It was found that this titanium offered no obstacle to the production of high-grade cast iron in the electric furnace, and that in a modification of this electric furnace this cast iron could even be decarburized to a very soft iron of high quality. Facilities were not at hand for smelting this iron in an ordinary blast furnace."

The report gives in great detail the preliminary work of the present investigation, including field examinations. Extensive tables are then given of analyses of more than 800 samples of black sand received from various districts in America. Then follow analyses of about eighty samples of concentrates from various localities in which only the gold and the platinum were determined and finally about seventy analyses are given, made by Messrs. Baker & Co., of Newark, N. J., of the percentage of platinum and iridosmium in assay buttons, since later investigations at Portland had developed many assays for gold where platinum was suspected.

Then follows the report by Prof. R. H. Richards on the methods of concentration. The following machines were used: screens, hydraulic classifier, hand jig, Wilfley table, Pinder table, Woodbury table, Christensen table, Wetherill magnet, greased plate, amalgamated copper plate.

Methods of testing sands are outlined and the complete tree of a process for examination of black sands in commercial work is given. Tables are then given of the results of concentration of sands from various localities.

The horse-power of the different concentrating machines used at the tests in Portland is given, but the amount of sands which each machine is able to treat in a certain time appears not to be stated. The cost of concentrating black sands on the Pinder table is estimated by Mr. J. Andrew Wauchope as 4.2 cents per ton, and by Capt. J. W. Pinder as 7.4 cents per ton. Mr. Arthur Goodall's estimate of the cost of concentration on Woodbury or Wilfley tables is 6.6 cents per ton, and Mr. A. W. Park's estimate on Wilfley table (omitting cost of water), is 3.9 cents per ton.

The Mine & Smelter Supply Co. has furnished the following estimate for a small plant for treating black sands, the first estimate being for ordinary gravel, too coarse for use with the sand pump, the second where the sand pump is substituted for an automatic feeder:

<i>Estimate of Cost of Plant for Treating Black Sands.</i>	
One standard type challenge ore feeder, complete....	\$80.00
One 6-inch bucket elevator, 20-foot centers, complete, with all necessary head irons, foot irons, and cast-iron elevator boot, necessary best grade of rubber belt, pressed-steel buckets and bolts.....	111.75
One revolving Trommel screen, 24-inch diameter by 6 feet long, complete, with sheet-iron housing, screen covered with 10-mesh, No. 18 steel wire screen	117.00
One revolving Trommel as above, except covered with 30-mesh, No. 28 steel wire screen.....	100.00
One No. 5 latest improved Wilfley table, complete, with middling elevator	450.00
One 9-hp. Stickney gasoline engine, complete, ready to run	375.00
For plant using 2-inch centrifugal sand pump in place of feeder and elevator, deduct price of feeder and elevator, or \$191.75, and add the price of:	
One 2-inch Card & Weber centrifugal sand pump, with chilled iron side plates and runner.....	90.00

Twenty feet of 2-inch pipe with elbow and 12-inch long nipple for delivering material into screen....	\$3.00
Shafting, pulleys, boxes, collars and belting, in either	
of the above estimates, approximately.....	70.00

ELECTRIC SMELTING.

The concluding part of the publication is the report of Dr. David T. Day, Mr. C. E. Wilson and Dr. G. Howell Clevenger on electric furnace experiments.

The first series of experiments was carried out by Mr. Wilson and was intended to produce steel in one operation from the black sands in the electric furnace and to determine to what extent the titanium usually found in the magnetite might effect the smelting process.

The design of the smaller and larger furnace used by Mr. Wilson has already been given in detail on page 5 of our Vol. IV. A considerable quantity of metal was produced in this first series of experiments. But "the product varied greatly, and, apparently, there was absolutely no control over the work of the furnace. Runs upon the same raw material would, in some cases, show low phosphorus and other runs would show high phosphorus. The same was true of the sulphur and the carbon, the carbon ranging from that contained in medium steel to that contained in white iron. In some cases, chemically, the product appeared to be good. Invariably the product was poor physically, being full of blow-holes."

Dr. G. Howell Clevenger, formerly associate professor of metallurgy in Stanford University, was engaged later on to extend this first series of experiments. His discussion of the results of the above mentioned first experiments is as follows:

"A process to produce steel direct from the ore would have to provide for the following requirements: 1. Reduction of the metal from the ore. 2. Oxidation of surplus carbon and impurities. 3. Deoxidation and killing. A consideration of the report on the first series of experiments shows that it is impossible to fulfill these requirements at one operation, as the conditions necessary for each are directly opposed to one another.

"All the slags made in these first operations were very ferruginous and consequently highly oxidizing. This is the case even with considerable excess of reducing agent and with sufficient lime to satisfy the acid constituents of the charge. This is due to the fact that the ore at once comes into the smelting zone and becomes melted before the iron is thoroughly reduced. Thus it will be seen that by this method requirements one and two are but imperfectly carried out, and absolutely no provision is made for requirement three.

"Reduction is very imperfect, as is indicated by the high iron content of the slags. Oxidation is irregular and uncertain, as is indicated by the erratic elimination of sulphur and phosphorus and the great variation of the carbon content when smelting the same charges and under the same conditions.

"As is well known, a very strong reducing action and a high temperature are necessary for the elimination of sulphur. Phosphorus may be eliminated by a ferruginous slag under proper conditions, but at a high temperature metallic iron reduces phosphorus from this type of slag. Thus the phosphorus passes back into the steel, even if once removed.

"In many cases the high carbon content of the metal was caused by absorption of carbon from the lining of the furnace. This theory is supported by the furnace tapping itself upon one occasion just as one of the charges was completely melted down. This metal was low in carbon, while charges run upon the same material, which were allowed to remain in the furnace for a time after fusion, were high in carbon.

"Deoxidation and killing is not provided for at all, the metal being tapped while in contact with the highly oxidizing ferruginous slag. This accounts for the large number of blow-holes and the general unsoundness of the metal. Summing up this method of working, it is imperfect as regards reduction of the iron and oxidation of the impurities, and further

deoxidation and killing of the metal are not provided for at all.

"And yet, notwithstanding the apparent very great weakness of this method, it is possible that, so far as electric smelting is concerned, it may prove the best practice where steel is the final product desired. Thus, during the reduction by sacrificing a portion of the iron, much of the carbon and other impurities can be kept out of the metal, and the further refining of the metal can be much more quickly accomplished than where the iron is completely reduced from the ore, in which case it contains the maximum amount of carbon and other impurities. The deciding point between these two methods of working would be whether it was more advantageous to allow a portion of the iron to go to waste or to expend more energy in refining the final product. Of course, in this connection, the total amount of energy used in either case must be considered; that is, reduction plus refining in each case."

In the second series of experiments, carried out by Dr. Clevenger, the process was divided into two steps; first, iron smelting and, second, steel making.

The general plan of operation was that the first smelting operation should be carried on in a furnace of the type used for the first experiments. In this furnace the metal would be reduced and part of the impurities removed, the molten metal being tapped into a second furnace without carbon in the lining, the current entering by one movable electrode and passing out through another. In this furnace oxidation could be finished and deoxidation and killing could be carried on to any degree desired.

The dimensions of the first furnace for smelting were: Bottom plate, 60 x 72 x 3 inches; shell, 60 inches in diameter and 60 inches in height; carbon crucible, 20 x 20 x 31 inches; thickness of sides of crucibles, 4 inches; of bottom, 28 inches; size of movable electrode, 10.5 x 10.5 x 38 inches.

The other furnace was of the Héroult type, designed to use two 4-inch electrodes. The lining was finely crushed chromite, held together by fireclay. This furnace was placed so that the metal could be tapped into it from the reduction furnace.

The first run was made in the reduction furnace upon magnetite, separated by a Dings magnetic separator from beach sand from the mouth of the Columbia River. During the first run the furnace equipment showed general weakness, and it was thoroughly demonstrated that carbon as a lining for the sides of a furnace of this type is not satisfactory. "When the furnace is cold, as in starting up, there is no difficulty if the electrode is kept centered; but as the furnace becomes hotter and becomes filled to a greater or less extent with metallic vapors, the arc will leap a longer distance, and the result is that the arc occurs at intervals between the sides of the furnace and the electrode."

In the next runs the carbon sides of the crucible were replaced by silica brick, and changes were made in the electrical connections to the furnace. But on account of the conditions under which the experiment was carried out, difficulties were again experienced which made it impracticable to use a high column of charge in the furnace, and it was found necessary to maintain an arc between the surface of the bath and the electrode, to feed in the charge a very little at a time, and thus to have absolutely no column of charge.

During these experiments 152 pounds of iron were produced with an expenditure of electrical energy estimated as 560 kw-hours (on the basis of an assumed power factor of 0.7). The iron produced was close-grained gray iron of remarkable toughness, containing 1.81 per cent Si, 0.07 Mn, 0.386 P and 0.012 S.

The electrode for this run was ordinary carbon, 10.5 x 10.5 x 36 inches; 51 pounds of the electrode were consumed. It lost in length about 2 or 3 inches, but had become pointed. This would account for the apparently large loss in weight for the quantity of iron produced. "It is the tendency of these electrodes to become pointed; hence they should be molded pointed in order to avoid to a certain extent this extra loss on a new electrode. The starting and the stopping of the

furnace, especially the stopping, are by far the hardest items of the run upon the electrode." Dr. Clevenger, therefore, considers the results of electrode consumption obtained from short runs to be misleading and invariably high. "As a result of the experience with the electrode of the first run, which was badly cracked and shattered when first heated up, all electrodes used in subsequent experiments were annealed before using—that is, they were heated until all moisture had been driven out of them. The electrode used in the second run was thus treated, and showed only a small amount of cracking, which did no damage."

At an early stage of the smelting the portion of the electrode exposed to the air became coated with slag and fine particles of charge thrown up from the furnace by the boiling. This protected the electrode from the action of air, and as a result the whole electrode, except at the point, remained intact.

The silica lining of the furnace was in places almost entirely eaten away. This was caused by the basic nature of the slag, due to the large quantity of iron it contained. This is due to the method of smelting with a shallow bath and no column of charge. The magnetite under this condition of operating is not completely reduced to metallic iron before it reaches the smelting zone, and hence it attacks the silica lining. The slags obtained by this method of working are invariably high in iron and very heavy.

Alterations in the equipment were again made for the next run. The furnace was lined with an acid lining made from crushed quartz, with 10 per cent of fireclay to bind it. This lining was round. Round 8-inch graphite electrodes were used instead of square carbon, and a new electrode holder was designed. The electrical connections to the furnace were also again changed. The charge consisted of 500 pounds Wyoming magnetite (passing $\frac{3}{4}$ -inch ring and containing 83.4 per cent ferric oxide and 14.1 titaniumoxide), 100 pounds charcoal, 15 pounds limestone and 5 pounds silica (99 per cent pure quartz).

The current was turned on and after running for about 5 minutes the charge was filled up to the top of the furnace. "Everything ran smoothly for several hours, then trouble commenced to be experienced by the charge partially fusing and hanging at the top of the furnace. At first this trouble could be remedied to a certain extent by working down the charge by means of raising and lowering the electrode. Later stoking down with iron bars had to be resorted to.

"After the furnace had been running for some time much trouble was experienced by violent boiling of the charge. This caused a great loss of efficiency in the furnace. This was caused probably by the small section of the furnace at the slag level and the fineness of the charge."

During the run six charges of Wyoming ore were run and four charges of black sand briquettes of 500 pounds each.

The briquettes were made up of 500 pounds magnetite fines, 100 pounds charcoal, 40 pounds lime and 50 pounds fireclay.

The total time of the run was 36 hours. The total iron in the charge was 2,583 pounds, and the total iron produced 2,246 pounds, so that 337 pounds of iron were lost in the slag. The energy consumption amounted to 3,760 kw-hours per 2,000 tons of pig iron. The consumption of the graphite electrode during the run amounted to 205 pounds.¹

The iron produced varied from white to gray. The analysis of one typical specimen of gray iron was 0.93 Si, no Mn, 0.074 P, 0.005 S, 4.3 total C, 0.530 Ti, 0.090 Cr.

The consumption of electrical energy per ton of pig iron produced is not so good as indicated by some other recently published figures¹; "but this is due to the high titanium con-

¹ A comparison of these figures with the results obtained at Sault Ste. Marie with the Héroult furnace (Dr. Haanel's report, our Vol. IV., page 265) seems interesting. At the Soo the electrical energy required for the reduction of 1 ton (2000 lbs.) of pig iron was 83 hp-days or 1485 kw-hours, which is less than four-tenths the energy consumption given above (3760 kw-hours) for the Portland experiments. The electrode consumption at Portland was 206 lbs. per 2246 lbs. of iron produced, or 182 lbs. per ton of iron, which is more than ten times the electrode consumption in the Soo trials (17.98 lbs. per ton).—Editor.

tent of the ores smelted, which necessarily requires more power to reduce, to the short duration of the experiment, and to the very irregular working of the furnace a part of the time.

"A very noticeable feature was the extraordinary consumption of electrode. There seemed to be very little tendency for the slag to form a protective coating upon the graphite electrodes, as in the case of the carbon electrodes. As a partial explanation of the heavy electrode consumption the following is offered: Conductors carrying heavy currents are surrounded by strong lines of magnetic force. This was very forcibly shown in this case by the attraction of iron bars and shovels when held near the cables carrying the secondary current, or near the graphite electrode. When the charge is fed into the furnace, the fine particles of magnetite are attracted by the electrode. Thus it is constantly surrounded by this material, which, when it becomes heated to a high temperature, becomes a very strong oxidizing agent; hence the rapid destruction of the electrode."

The steel furnace in which the iron reduced in the first furnace was to be treated had a lining of crushed magnetite and tar. The original idea of tapping the molten metal from the first furnace into the refining furnace had to be abandoned on account of the fact that not enough current was available to run both furnaces at once. While the experiments show the possible elimination of impurities, the report does not indicate that any conclusive results were obtained. It is said that much difficulty was experienced in getting proper refractory material.

* * *

The results of these electric furnace experiments are disappointing in so far as they have not yielded any definite quantitative results; on the contrary, former investigations by other investigators, especially with the Héroult furnace and with the Colby-Kjellin induction furnace, have given far more important and concise information on electric smelting and refining than were obtained at Portland. But the Portland research was evidently not made for such a purpose.

The report of Dr. D. T. Day and Prof. R. H. Richards is undoubtedly a valuable contribution to the literature on black sands. It is a conservative document, and in view of our former criticisms (our Vol. IV., p. 339 and 469) of unofficial or semi-official accounts of the Portland experiments, it is only fair to state here that the official report contains nowhere the ridiculous claim (or anything like it) that the Portland experiments have shown that steel can be made from black sand for \$12 per ton.

The "Pinsh Effect."

A very interesting paper was presented by Dr. E. F. Northrup (of the Leeds & Northrup Co., of Philadelphia) on March 2, before the American Physical Society, at Columbia University. The paper relates to certain forces which exist in the interior of an electric conductor, and which manifest themselves at high current densities if the conductor is liquid, and therefore susceptible to deformation.

The fundamental observation was made by Mr. Carl Hering, when a relatively large current was passed through a horizontal liquid conductor. The liquid seemed to disobey the ordinary laws of gravity by flowing up-hill onto the electrodes, and standing at rest with its surfaces at steep angles of 45° and over. The liquid acted as though the column were forcibly contracted in cross-section.

Dr. Northrup has developed the theory of the phenomenon and confirmed his formulas by experiments. The gist of his argument is that the current elements near the outer surface of the conductor tend to move toward the center across the lines of force which are in the conductor itself. This tendency is exactly the same as that of any conductor carrying a current which tends to move across lines of force.

The Butters Slime-Filter at the Cyanide Plant of the Combination Mines Company.*

BY MARK R. LAMB.

The slime at the Combination Mill at Goldfield, Nev., averages perhaps \$20.00 per ton, and for its treatment the canvas-cell filter is used, developed by Chas. Butters and his staff. By the use of this filter slime can be treated at a lesser cost and with a higher percentage of gold—or silver—extraction than in the ordinary treatment of sand; and, moreover, the initial outlay for an all-slimer plant is less than that for the ordinary sand and slime plant.

The economy of construction of the Butters filter plant is clearly shown in Figs. 1 and 2, which illustrate the 20-frame filter of 40 tons capacity now being installed by the Nevada

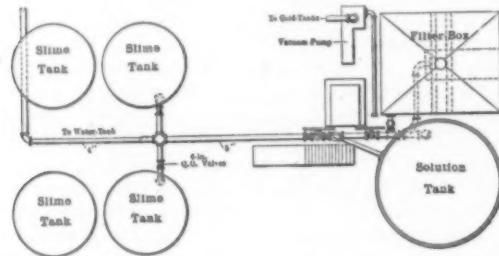


FIG. 1.—THE 20-FRAME FILTER OF THE NEVADA GOLDFIELD REDUCTION CO. (PLAN.)

Goldfield Reduction Co. In this construction the slime pump is so connected that it can pump to or from either tank or the filter by changing the valve settings—a combination which is necessary in this particular installation, since sufficient fall is not available for filling and discharging the filter by gravity.

Ordinarily, a slime plant comprises a filter box with frames or cells, two tanks of double the capacity of the filter box, for slime and water, respectively; a "wet" or "dry" vacuum pump, or other source of vacuum; a centrifugal slime pump, and a series of agitation tanks, which also provides storage for the

are merely the filter and a source of vacuum. Furthermore, the unused settling and treatment tanks can be used as treatment tanks, thus increasing the time of treatment, if desirable, and also increasing the capacity of the plant.

The cycle of operations is as follows: The slime, after agitation in solution the required time, is pumped into the filter box. As soon as the latter is full the filter is connected to the source of vacuum and the gold solution drawn from the pulp through the canvas of the cells, while the slime forms a layer on the outer surface of the canvas. While the slime cake is being formed the filter box is kept full of slime pulp by pumping it in as fast as solution is drawn out through the frames.

When this layer is of suitable thickness (which depends on the permeability of the slime) the vacuum is reduced to a

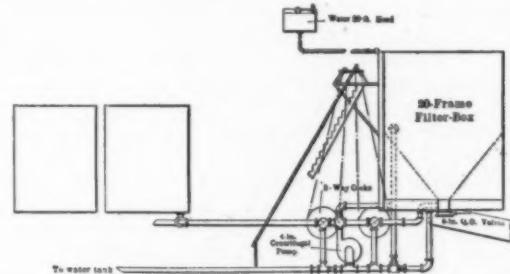


FIG. 2.—THE 20-FRAME FILTER OF THE NEVADA GOLDFIELD REDUCTION CO. (SIDE ELEVATION.)

pressure barely sufficient to hold the slime in place, and the pulp still in the filter box is returned to its storage tank. The centrifugal pump is set to fill the filter box with water, the vacuum is raised, and the slime cake is washed. This water, which passes through the filter, is sent to the gold tank. When desirable the slime can be given a wash with solution before washing with water. This will be done at the Nevada-Goldfield plant.

When all dissolved metal is removed from the cake it is dropped from the canvas by merely breaking the vacuum and turning water or water and air into the cells under a pressure of about 10 pounds per square inch. A period of 5 minutes suffices to drop the slime. Surplus water in the filter is then drawn off, if the saving of small quantities of water is desirable, and the bottom discharge valve opened. The slime, containing from 20 to 40 per cent of moisture, is discharged in less than a minute.

The time required for the treatment of one lot of slime is about 3 hours, depending upon the thickness of the cake, the size of the slime pump and the permeability of the material—all matters which can be determined in advance. The filter is used six or eight times in 24 hours. Correctly speaking, the slime is not treated in the filter, since agitation and extraction of the values take place before the filter is reached. In other words, the filter is used solely to displace the metal-bearing solution. In Mexico, the filter is handled by one Mexican peon per shift. These peons learn quickly and are entirely satisfactory.

One of the most important and vital features of the filter is the fact that the regulation of the thickness of the layer of slime depends upon its permeability. Thus, if fine sand is mixed with slime it tends to collect on the bottom of the center cells (which are directly over the inlet from the pump) in a proportionately thicker layer, thus causing all parts of the layer of slime to be equally washed.

The economy in time for complete displacement by the Butters filter (from 15 to 20 minutes, see Table I.) is plainly evi-

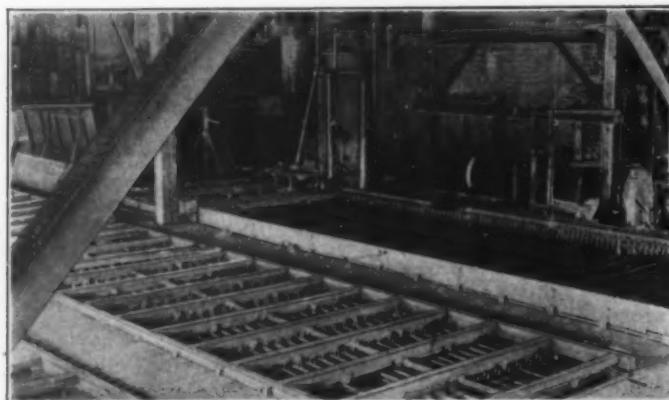


FIG. 3.—THE 90-FRAME FILTER BOX AND ELECTROLYTIC PRECIPITATION VATS AT VIRGINIA CITY PLANT.

slime. With regard to the economy in labor required to operate the Butters filter plant, 500 tons of slimes, or even more, can be treated, filtered and discharged by one man per shift—a remarkable gain as compared with ordinary practice in filter pressing.

Where the filter is installed to replace treatment by decantation, no extra tanks are required, and the necessary additions

* An Am. Inst. Min. Eng. paper, slightly abstracted from the January issue of the Bi-Monthly Bulletin of the Institute.

dent when compared with the usual practice, using a press or by decantation. The Virginia City plant of Chas. Butters & Co. is now treating ores from Tonopah, the slime of which settles very slowly. The pulp is brought to the plant with about 100 parts of water to 1 of slime, which condition will be changed shortly, but which now makes a secondary de-

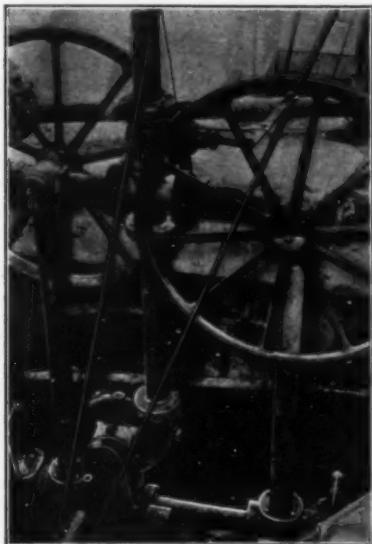


FIG. 4.—SLIME PUMP, THREE-WAY COCKS, VALVES AND PIPING AT COMBINATION PLANT.

watering filter necessary. This latter device works well, and but for it the slime could not be treated except with a large loss of solution.

According to the paper by Charles Butters and E. M. Hamilton, entitled "On the Cyaniding of Ore at El Oro, Mexico, Dealing Principally with Regrinding of Sands," describing practice at El Oro, Mexico, slime can be made of sand at a cost of \$0.53 gold per ton. The cost at the Combination Mill is a little less than this figure.

It is rarely the case that the difference in value between sand and slime tail assay would not exceed this amount, and including the occasional (?) slimy sand tank, with which the cyanider must contend, calculation will show that many plants could largely increase profits by sliming the entire product.

Fig. 3 is a view in the Virginia City plant, showing the electrolytic precipitation vats in the foreground, directly in front of a 90-frame filter box, which has a capacity of from 150 to 200 tons per day.

Fig. 4 shows the slime pump, three-way cocks, quick-opening valves and piping at the Combination plant, which arrangement, as previously explained, is necessary only where sufficient grade is not available.

Fig. 5 shows the end view of the lower half of the filter box, and at the right-hand side the geared vacuum pump.

Fig. 6 shows one leaf of the filter, which has lines of stitching in order to resist the internal pressure.

Fig. 7 is a perspective view of a plant of 100 tons daily capacity, comprising filter box, slime and water storage tanks above, the slime storage tank below, the vacuum drum con-

nected to the filter leaves and to the gold sump and the gold solution and slime pumps.

Fig. 8 is a detail view of the filter box shown in Fig. 7, with filter leaves in position, some shown in section and some removed.

The list of tests, made to show results which were being attained at the Combination plant,² is given below.

It should be explained that "water" wash was, in reality, solution assaying \$0.60 per ton, which would otherwise be waste solution. This water, as it is drawn through the slime cake, does not go to the zinc boxes, but is used to replace the weak wash which is precipitated. The weak wash assayed \$4.02 per ton.

TABLE I.—SOLUTIONS FROM A CAKE 1.25 INCHES THICK.
Weak Wash.

Time.	Value Per Ton.
After 2 minutes.....	\$12.22
" 4 "	12.20
" 6 "	11.89
" 8 "	11.96
" 10 "	11.40
" 12 "	10.90
" 14 "	8.90
" 16 "	6.82
" 18 "	4.76
" 20 "	4.46
" 22 "	4.26
" 24 "	4.12
" 26 "	4.10
" 28 "	4.02

Water Wash.

Time.	Value Per Ton.
After 5 minutes.....	\$3.66
" 10 "	3.62
" 15 "	3.12
" 20 "	0.60
" 25 "	0.60
" 30 "	0.60

The practice at the Combination Mill is to wash from 16 to 18 minutes with solution and the same length of time with water.



FIG. 5.—END VIEW OF LOWER HALF OF FILTER BOX, WITH GEARED CENTRIFUGAL PUMP AT THE SIDE, COMBINATION PLANT.

The ordinary slime-settling device, whether tank or spitzkasten, rarely produces a product with less than 60 per cent of moisture, and in many cases the proportion is three or four

¹ Institution of Mining and Metallurgy, Vol. XIV., pages 3 to 46 (1904-05).

² Engineering and Mining Journal, Vol. LXXXI., pages 1,236 to 1,238 (1906).

to one. This water must necessarily dilute the cyanide solution added to the slime, or, in case cyanide is added to the slime without further addition of solution, this solution, after precipitation, must be run to waste. Of course, the ideal way is to mill in solution, though for other reasons this is not always desirable.

When milling in water, by a proper arrangement of pipes and valves, and by providing a filter of sufficient capacity, the settled slime can be dried to any economical degree of moisture, and by filling the filter box with solution the slime can be pulped again by means of the centrifugal pump and returned to the agitators, thus avoiding the necessity of making solution which must be run to waste.

As an example of what can be done, 100 tons of slime, if treated without removing the water, will cause the loss of about 75 tons of weak solution, containing about 0.8 pounds of KCN per ton, or 60 pounds. If the Butters filter is used this loss can easily be reduced to 8 pounds without additional expense.

Particular attention should be paid to the thoroughness of the wash. After 20 minutes, if pure water be used, the wash-water from the slime at the Combination Mill shows no measurable quantity of cyanide.

The quantity of solution made by washing is much reduced

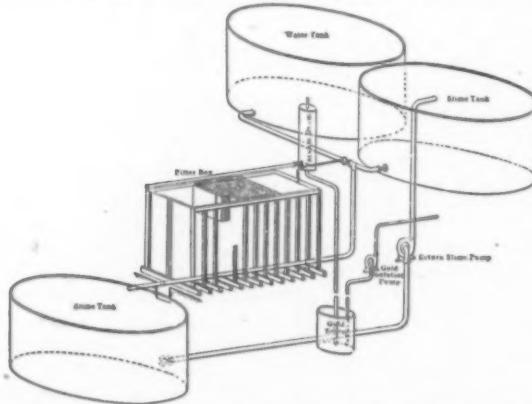


FIG. 7.—VIEW SHOWING ARRANGEMENT OF A 100-TON SLIME FILTER.

in volume when compared with the amount necessary for washing a filter press charge. In fact, the wash-water will about make up for evaporation losses when ore is milled in solution.

Experiments are now under way with a view of doing the entire treatment on the filter, thus saving tankage and time. These experiments will only succeed with ores such as that treated at the Homestake slime plant, where extraction from slime is almost instantaneous. Such treatment would not succeed with a silver ore, for example, where long agitation and aeration are required.

I feel confident that this filter will be the cause of many plants abandoning entirely the treatment of sand, thus reducing the cost of installation, depreciation and operation, and increasing the capacity and the extraction.

Atomic Weights.—The report of the International Committee on atomic weights for 1907 has been published in the February issue of the American Chemical Society. Important changes are: Nitrogen, from 14.04 to 14.01; bismuth, from 208.5 to 208.0; tantalum, from 183 to 181; terbium, from 160 to 159.2. The atomic weight of silver, as deduced from Stas' data, is probably too high, but by an unknown amount.

The Electric Furnace in the Pottery Industries.

At a recent meeting of the English Ceramic Society, Dr. R. S. Hutton, of the University of Manchester, presented an interesting lecture, with demonstrations, on electric heating and its application to the fusion and firing of refractory materials. The electric furnace served at first solely for the initiation of new industrial processes, demanding temperatures quite beyond the scope of fuel heating. But now electric heating is being widely applied in cases where the temperatures required are just within the limit attainable with gas or coal firing, and the general tendency is undoubtedly towards its

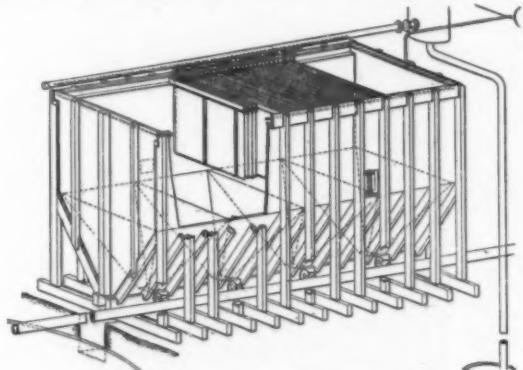


FIG. 8.—DETAIL VIEW OF FILTER BOX.

use for still lower ranges of temperature. Dr. Hutton is careful to emphasize that there is no panacea in the word electricity, and that improvements in economy and convenience are the explanation of the extended use of the electric furnace beyond its original high-temperature sphere. As a matter of fact the success of the application of electric heating often depends more on the appalling inefficiency, due to the wasteful employment of coal, in the process being displaced than upon any intrinsic advantage of electric heating.

The chief advantages of the application of electricity for heating are: 1, that it enables the heat to be generated just where it is required—inside rather than outside the heating chamber; 2, the simplicity of a delicate regulation of temperature; 3, the ease with which the furnace or kiln can be provided with a really efficient heat insulation, capable of economizing the thermal losses to the outside air.



FIG. 6.—ONE LEAF OF THE FILTER, SHOWING REINFORCEMENT BY STITCHING, COMBINATION PLANT.

Dr Hutton's paper makes suggestions as to what might be hoped from the electric furnace in the pottery industry, and

discusses in the first part the use of the electric furnace for experimental work in the laboratory of a pottery. The principal object would be a thorough and methodical experimental study of the changes in the physical properties of the various oxides and other bodies which enter into the composition of their raw materials, caused by a variation in the temperature at which they have previously been fired.

Something has already been done in this direction. Dr. Hutton mentions the work of A. Ditté on magnesia (*Comptes Rendus*, 73, III, 191, 270, 1871), and H. Le Chatelier on silica (*Comptes Rendus*, III, 123 to 126). Some more recent work on magnesia¹, magnetic oxide of iron² and alumina³ is interesting, as it shows how very greatly the properties of these materials are altered by exposure to high temperatures in the electric furnace. In the case of alumina at least application has already been made to the ceramic industry.

Another application for which the electric furnace is specially suitable is the determination of the temperature at which a ceramic material fuses or, perhaps, rather, the determination of the point at which the material begins to soften and lose its shape.

As electric furnaces suitable for laboratory work of this kind some simple types of resistance and of arc furnaces are described by the author. Among the resistance furnaces he distinguishes between such with metallic heating wires and such with carbon resistors. In the latter solid carbon, for instance, in form of carbon tubes may be used, or the carbon may be applied in granular form so as to surround the heating chamber. The granular carbon should be ground, sieved and graded; the heating being much more uniform if the grains are approximately of the same size. Furnaces of this type have been widely adopted; at the Berlin Porcelain Works they have been used up to about 1,700°. (M. Simonis and R. Rieke, Sprechsaal, 39, 589 to 591, and 633 to 635, 1906.)

In the second part of his paper Dr. Hutton reviews several industrial electric furnace processes. He first speaks of carborundum and siloxicon. He mentions the work going on in Niagara Falls, tending to put the manufacture of bricks, crucibles, etc., of siloxicon on a commercial basis. Much attention has also been given of late to the problem of agglomerating the powdered carborundum with a view to making strong vessels of this material. (See F. A. J. Fitzgerald, Carborundum, Halle, 1904; Carborundum Co., Eng. Pat. 9,963, 1904; E. G. Acheson, U. S. A. Pat. 722,793, 1903; L. E. Müller, French Pat. 329,232, 1903; Gebr. Siemens, Eng. Pat. 21,347, 1905.) Amongst other similar uses the lining of the kilns with bricks coated with a thin layer of carborundum may be mentioned.

After a few notes on artificial graphite the author gives a review on the fusion of alumina. The object of this work, in the first place, was the production of artificial rubies. After much painstaking work, in which other French scientists have taken part, Verneuil has succeeded in producing fairly large masses, and has recently described his most ingenious method

¹ Paper by H. M. Goodwin and R. D. Mailey, our Vol. IV., page 216.

² In our Vol. III., page 392, a patent by H. Specketer, assigned to the Griesheim Elektron Company, was mentioned. He melts in the electric furnace ferric oxide, to be used in form of electrodes which are said to be specially suitable for chloride electrolysis. According to private reports received, these electrodes are now used on a large scale in Germany, and are proving successful. The chief advantage over carbon electrodes is said to be that the chlorine developed is free from carbonic acid. It is also said that a certain disease of workingmen which was attributed to the volatilization of certain substances used as binding materials in the carbon electrodes, has ceased since the introduction of the ferric oxide electrodes.—Editor.

³ Dr. M. Buchner has done important work in this direction, as was first noticed in Dr. Hans Goldschmidt's Electrical Congress paper, our Vol. II., page 466, on the use of corundum (the pure alumina slag from the thermit reaction of production of metallic chromium) for vessels which can be suddenly heated or cooled without danger of cracking. The same "Buchner patent material" is also used for diaphragms, as noticed in our Vol. IV., page 237. See also M. Buchner, "Zeit. f. Angew. Chemie," 17, 965 to 988, 1904, and "Chemical Trade Journal," 35, 388, 1904.

of working. (Verneuil, *Ann. Chim. Phys.* [8], 3, 20-48, 1904. For historical account see H. Marour, *Revue Chim. pure et appl.*, 6, 72-77, 1903.)

The author then referred to the very successful commercial work of the Norton Emery Co., who produce alundum, that is, artificial emery, made by fusion and purification of alumina in the electric furnace. At Rheinfelden a similar product is being manufactured, but is called "Diamantin." The Goldschmidt Thermit Co. is also employing as an abrasive the fused alumina, which occurs as a by-product of the processes which they carry out. (See footnote 3 above.)

In this connection is to be mentioned the application of fused alumina to the production of a new "pottery body." This development has been carried out by an important German firm of potters (Deutsche Steinzeugwarenfabrik, of Friedrichsfeld) in conjunction with a leading chemical works. (See footnote 3 above.) The different articles made from this new material are said to possess to a remarkable degree the power of withstanding sudden heating to a high temperature. This is due to the very small contraction which occurs in articles made with suitable mixture of the fused alumina and clay.

It would indeed be of interest to know the relative behavior of other completely "shrunk" oxides, etc., when used in a similar manner; by actual fusion in the electric furnace these materials can be obtained in a condition in which subsequent heating causes no further contraction. The strength of bodies made of such materials when subjected to severe thermal treatment probably depends much more upon the completeness of this "shrinking" than upon the thermal conductivity.

Dr. Hutton then speaks about magnesia. Since magnesia is the most refractory of the commonly occurring oxides, it is surprising that it is not more widely employed for the construction of vessels capable of withstanding high temperatures. Up to the present, however, ordinary calcined magnesia has been found none too well suited for this purpose. Magnesia bricks, crucibles, etc., of nearly all makes require very great care in handling, and it is particularly necessary in furnace work to heat them evenly and slowly, otherwise fracture occurs.

Recently the electric furnace has been used to fuse or shrink magnesia (see E. K. Scott, our Vol. II., p. 454; Vol. III., p. 140), and much may be expected by the application of such products for the manufacture of crucibles, etc.

Pure magnesia tubes and other vessels of small size are now made by the Royal Porcelain Factory, at Berlin, but on account of their high cost are obviously of greater importance for scientific than for technical work. There is, however, nothing to hinder the cheap production of electrically shrunk magnesia on a large scale, so that further developments along these lines may confidently be expected.

Arc furnaces very similar in general type to those employed in the manufacture of calcium carbide have been used technically for the production of fused alumina and magnesia, and, where it is desirable to produce a really fused and liquid product, there are somewhat great difficulties in the way of using a resistance furnace with material packed around a central core. On the other hand, much can be done with resistance furnaces, and large masses of magnesia can be heated to near the melting point, and caused to recrystallize with a very simple type of furnace, and with considerably lower power expenditure than is incurred with the arc type of furnace.

The author finally made a few remarks on what he calls silica glass, or what is called by others fused silica or fused quartz. The manufacture of this product has within the last few years shown signs of developing into a flourishing little industry.

The quartz fibers of Boys were followed by the tubes and small vessels of Shenstone, but in both cases it was the oxy-hydrogen blow-pipe which served as the source of heat. The working of the material was consequently both tedious and expensive.

Recently the electric furnace has been called into service with most satisfactory results. Relatively large tubes have been obtained from quartz crystal of Calais sand, both by indirect heating with the electric arc and also by passing the electric current through a carbon core surrounded by sand. (R. S. Hutton, *Mem. Manch. Lit. and Phil. Soc.*, 46, VI, 1-5, 1901; *Trans. Amer. Electrochem. Soc.*, 2, 105-111, 1902; our Vol. I, p. 58.) "Recently the electrical process has been developed, and a method discovered for blowing and shaping vessels from the semi-fluid material produced around an electrically-heated core. (Eng. Pat., 10,670, 1904.) With these and other improvements the Thermal Syndicate, of Wallsend-on-Tyne, is producing large pipes, bricks, dishes, insulators, pyrometer tubes and a variety of other ceramic articles."

The advantages of fused silica are its low coefficient of expansion, its highly refractory nature and its extreme hardness. In the discussion which followed, Dr. J. W. Mellor said that the properties of fused silica reminded him of fireproof china, "and some of us, on the morrow, will no doubt try how this substance will work in pottery bodies." He also had no hesitation in saying that the electric furnace opens up great possibilities in the preparation of "a new palette of pottery colors."

Electrochemical Problems.

In our last issue, page 41, we gave the first part of a list of problems on subjects bearing on electrochemistry, some of which, it is intended, shall be discussed at the next general meeting of the American Electrochemical Society in May, in Philadelphia. We herewith give the concluding part of this list of problems.

The study of the law of energy in electrochemical reactions; including the disputed question whether, in electrochemical decompositions that compound will first decompose which requires the least energy to decompose it. Also including the question whether a compound can be decomposed with a voltage less than that required by theory, from the energy of decomposition.

When a horizontal anode is placed about a half or quarter inch above a layer of mercury and in a solution of acidulated zinc sulphate, the mercury being the cathode, hydrogen will be evolved freely from the mercury at moderate current densities; when the current is then increased, a point will be reached when no trace of gas is evolved immediately below the anode (which should be smaller than the cathode), while outside of this area there will be free gassing. What is it that takes place over the non-gassing area, and can it be used for the deposition of the zinc in the mercury without the evolution of hydrogen?

A study of the thermo-electromotive forces between solids and liquids. They are very much greater per degree than those between solids.

The heat conductivities of linings for electrical furnaces. The temperatures and conditions under which the linings of electrical furnaces become electrically conducting; and the specific resistances under those conditions and at those temperatures.

Electrolysis without electrodes. Is this possible, and if so, what is it that takes place, and where?

In the electrolysis of acidulated water, when using the same anode, it will require widely different voltages to set free hydrogen with different metals for the cathode; it will be least when this metal is platinized platinum, and quite great when it is mercury. The excess of voltage over that in the former case has been called "over voltage." What is the seat of the energy represented by this excess of voltage? What does this energy do, and in what form is it after the reaction?

If a glass tube is filled with an electrolyte in solid form and provided with electrodes at both ends, and if, by the applica-

tion of heat to one end, this electrolyte becomes a liquid at only one electrode, at what place will the electrochemical reaction, corresponding to that at the other electrode, take place if the electrolyte is of such a nature that it changes gradually from the solid to the liquid state, passing through a semi-liquid state? It cannot take place in the solid part, and there is no definite line of demarcation between the solid and liquid parts, yet it must take place somewhere, as a unipolar electrochemical reaction is unknown.

If an electrode of zinc and another of amalgamated zinc be placed in a solution of zinc and the electrodes connected externally, a current will flow in the external circuit from the zinc plate to the amalgamated one and zinc will be deposited in the former. What is the source of energy of this battery? It has been thought to be thermal, and that the liquid cools by virtue of this reaction, thereby absorbing heat from the air. If so, it would offer a direct means of changing the heat energy of the air into an electric current, and would seem to be contrary to the second law of thermo-dynamics.

Electrolytic production of magnesium.

Electrolytic method for determining silver in base bullion and dore bars.

What is the white substance formed on copper anodes when refining copper with a high current density and a cold solution?

Electric Steel.

In our January issue, page 25, we gave short abstracts of two papers recently presented before the Verein Deutscher Eisenhüttenleute, one by Eichhoff on the Héroult process as operated at Remscheid, and the other by Roechling on the induction furnace. Further notes on Prof. Eichhoff's paper, the original German text of which is printed in full in *Stahl und Eisen* of Jan. 9, were given in the Synopsis of our last issue, page 58. In the following we give further notes on the paper of Mr. HERMANN ROECHLING from the original text in *Stahl und Eisen* of Jan. 16:

Induction furnaces have certain characteristic features. First, there are no electrodes. Second, liquid rather than solid charges should be treated. Third, the heat is produced in the metallic bath rather than in the slag; if a specially high temperature of the slag is required, special devices must be used.

It has long been recognized that there is considerable difficulty in charging and discharging the narrow annular crucible of an induction furnace. Kjellin in Gysinge uses two tapping holes. But this has disadvantages. To overcome them the furnace used at Voelklingen is built as a tilting furnace as shown in the adjoining diagrams. The furnace is suspended so as to turn on two journals, so that when the back is raised the mouth is lowered and the furnace can be discharged entirely. The construction can be clearly seen from the illustration.

In the induction furnace like any other properly designed electric furnace, it is possible to remove sulphur and phosphorus to mere traces (some analyses of steel produced by the author show 0.02 or 0.03 or less per cent of phosphorus and sulphur). At a high temperature it is possible to maintain a liquid lime slag, almost free from oxide, upon and in most intimate contact with the steel bath. This has a strong desulphurizing effect. The author claims that manufacturers using electrode furnaces, add considerable quantities of fluorspar to their lime slag in order to desulphurize the bath. He says that this has not been necessary in his own experiments with the induction furnace. Even without such an addition the slag was sufficiently fluid.

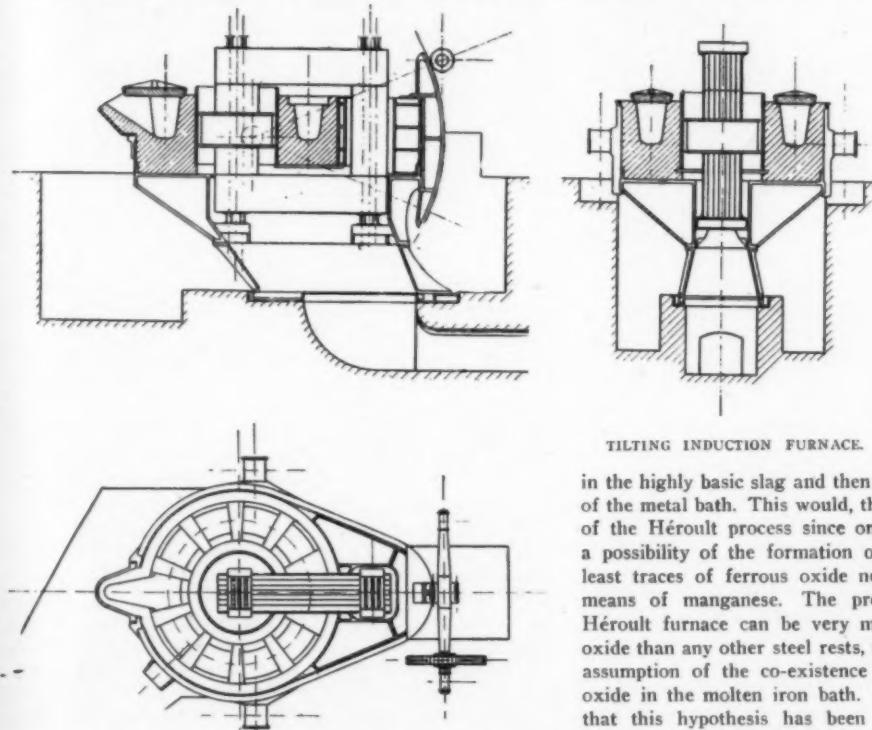
The removal of large quantities of carbon is difficult if simultaneously large quantities of phosphorus are present. The less the quantity of phosphorus in the iron the easier it is

to remove the carbon. With 0.1 per cent of phosphorus there is no difficulty. It is similar with manganese and silicon.

With respect to the deoxidation of the bath, this is not possible if the slag contains any appreciable amount of compounds of iron and oxygen. Such a slag must therefore be removed. At Voelklingen, powdered lime is then simply added to the bath to form a new slag. If necessary this is repeated with simultaneous addition of reducing agents and a complete deoxidation is obtained.

The experiments in Voelklingen were made with two furnaces, one containing 50 to 60 kg. (110 to 130 pounds), and the other 300 kg. (660 pounds). Alternating current of 50 periods was used. With the smaller furnace the power factor was very satisfactory; the figure given is 0.95. For the larger furnace no figure is given; it is said that the power factor is poor, but it is hoped to improve matters.

To melt pig iron and heat it to about 1,200° C. (about 2,200°



F.), about 385-kw. hours per ton were required in the 300-kg. furnace. To complete a charge of scrap, about 600-kw. hours are required. The cost of this amount of electrical energy would be too high to render the process economical, and this is the reason why molten metal (instead of cold scrap, etc.) should be charged into the furnace, since in this way a considerable amount of electrical energy may be saved.

By starting with molten Thomas steel or Martin steel, it is possible to refine the bath with a low expenditure of energy. For instance, at Voelklingen it has been found repeatedly possible to completely deoxidize ordinary molten Thomas steel and to remove sulphur and phosphorus down to mere traces and to rebarberize the metal to 1 or 1 1/2 per cent of carbon and to finish the charge, with the total expenditure of 150 to 200-kw. hours per ton. With this expenditure it was possible to produce the finest sorts of crucible steel. If it is considered that this is possible with a furnace which contains only 300 kg. (660 pounds), it is evident that with a larger furnace much better results may be obtained. "The future of the electric furnace, therefore, does not rest in melting cold charges and replacing our ordinary metallurgical processes, but the electric furnace should be used rather as a supplement to our old processes in order to enable any steel plant to pro-

duce the finest qualities of steel from open-hearth steel at comparatively small costs."

To reduce the power consumption, two means are available. Either the size of the furnace is increased, to reduce the losses, or the metallurgical process is carried out as quickly as possible, since then the heat loss per unit of output will also be reduced.

The two papers of Prof. Eichhoff and Mr. Roechling were discussed together. Dr. Hans Goldschmidt gave some notes on the Stassano arc furnace. Stassano does not make, at present, steel from ore, but simply refines steel scrap. A revolving furnace of 1,000 hp. is to be started very soon.

Engineer Eilender spoke briefly about the process of Girod, which is very similar to the Héroult process, although only a single carbon electrode above the bath is used, the other terminal being a water-cooled, steel casting in the bottom of the hearth. He then criticised some remarks of Prof. Eich-

hoff on the manner in which the deoxidation takes place in the Héroult process. Eichhoff claims that iron carbide and ferrous oxide can exist together within certain limits in a liquid iron bath. A further deoxidation of the bath by addition of carbon would, therefore, not be possible. In the Héroult process, however, the deoxidation is carried further on account of calcium carbide being formed at the high temperature of the arc; the calcium carbide dissolves

TILTING INDUCTION FURNACE.

in the highly basic slag and then reacts with the ferrous oxide of the metal bath. This would, therefore, be a specific property of the Héroult process since only with this process there is a possibility of the formation of calcium carbide. Only the least traces of ferrous oxide need be rendered harmless by means of manganese. The proof that steel made in the Héroult furnace can be very much more free from ferrous oxide than any other steel rests, therefore, finally on the above assumption of the co-existence of iron carbide and ferrous oxide in the molten iron bath. Mr. Eilender does not think that this hypothesis has been completely proven by Prof. Eichhoff. The latter will discuss this matter in a separate article.

Director Bian asked about the variations of the load during operation. Chief Engineer Engelhardt stated that they were 5 per cent in Gysinge, while Roechling said that in Voelklingen the load curve is practically a straight level line.

Prof. Eichhoff finally pointed out again that the Héroult furnace operates with one or more oxidizing slags (for removing the impurities) and then with one slag of lime and sand for deoxidation.

Jamestown Exposition.—There will be six groups of the metal and ore exhibits in the Department of Mines and Metallurgy at the Jamestown Exposition. First, structural materials and building supplies (cement and cement products, etc.). Second, hardening materials for iron and steel. Third, gems. Fourth, those minerals from which chemical compounds used in the lighting industry are derived. Fifth, clay products. Sixth, State exhibits. There will, of course, also be exhibits of mining machinery. A pavilion will be erected near the Mining Building, where all of the most approved forms of concentrating machines will be installed for determining the best methods of concentrating sands and gravels. Dr. Joseph H. Pratt will be chief of the department.

Notes on Electrochemistry and Metallurgy in Great Britain.

(From Our Special Correspondent.)

SAMPLING—ASSAY OF SILVER BULLION.

The first paper read before the Institution of Mining and Metallurgy at their meeting on Jan. 17, dealt with "Some Sampling Results," and was presented by Mr. E. H. GARTHWAITE. The question of how close, or how far apart samples should be taken is of great importance, and the author's paper throws an interesting light upon the subject. The paper is full of comparative results, and the conclusion to be drawn is that where the ore fluctuates very much in value, it is unsafe to sample at greater intervals than 4 feet, for while results from greater intervals might give a correct general average, it is not safe to trust them. It was also suggested that if samples at 1-foot intervals could be obtained, it could be definitely determined whether it would be possible safely to increase the interval to 5 feet, or better to reduce it to 3 feet.

The second paper, presented by Mr. ERNEST A. SMITH, described "The Assay of Silver Bullion by Volhard's Method," of which the following are the leading features:

For some years it has been the practice at several assay offices to modify slightly the ordinary method of finishing the assay by adding sufficient ammonium thiocyanate to the check assay to intensify the red color of the ferric thiocyanate and use this color as a standard of comparison. By this means the finishing point of the assay is perceived more sharply and with greater certainty than is possible when the assay is finished in the usual way by cautiously adding the deci-normal solution until the first indications of a permanent red coloration are seen. No figures showing the limit of accuracy attainable by this slight modification appear to have been published hitherto; the results of a series of experiments made by the writer, in conjunction with Mr. G. Sims, to determine this point and the best conditions of working may, therefore, be of interest to the members of the Institution. The experiments proved that, by finishing the assay as above indicated, a limit of accuracy less than 0.1 per 1,000 of silver can be obtained by Volhard's method. The following conditions of working were found to be the most satisfactory:

A "normal" solution of ammonium thiocyanate is prepared of such strength that 100 cc. is equivalent to about 1.0003 to 1.0005 grm. of silver.

On adding 100 cc. of this solution to a solution containing exactly 1 grm. of pure silver, the slight excess of ammonium thiocyanate present beyond that necessary to precipitate the silver produces, in the presence of a ferric salt, the permanent red coloration used as the standard of comparison or check.

After the addition of the normal solution the stopper is inserted and the bottle well shaken for 2 minutes; it is then allowed to stand until the precipitate settles, leaving the pale red colored solution perfectly clear. This color, as previously stated, is used as a standard of comparison, and all assays are worked to it. The addition of 0.5 cc. of deci-normal silver nitrate solution should render the solution colorless, and it is necessary to adjust the strength of the normal solution to secure this result, experience having shown that the accuracy is impaired if the color for comparison is too dark.

In assaying silver bullion (the fineness of which must be approximately known) the quantity taken is such that about 1 grm. of silver is present; it is dissolved in 10 cc. of dilute nitric acid and treated as previously described. When the liquid has cleared after shaking, the color of the solution at once shows whether silver or thiocyanate is in excess, and also indicates the approximate fineness of the bullion and the quantity of deci-normal solution required to finish the assay.

Deci-normal thiocyanate solution is carefully added from a burette until the color approaches that of the check; the liquid is then shaken and allowed to clear; after which, the

deci-normal solution is cautiously run in, drop by drop, until the color corresponds exactly to that of the check. The addition of one drop (0.05 cc., equivalent to 0.05 mgm. of silver) of deci-normal thiocyanate makes a perceptible difference to the color, which is readily recognized.

It is the extreme delicacy of the reaction between the thiocyanate and the ferric salt which is taken advantage of in the modification described, and also makes it possible to see the end of the assay with much greater certainty and accuracy than is the case when the assay is finished in the usual way. For, as Mr. Beringer has pointed out, it is the red coloration produced by the thiocyanate when the assay is nearly, but not quite, finished, and the slowness with which this is removed on shaking, that constitute the chief disadvantages of the Volhard method.

Experience has shown that equally accurate results are obtained whether the silver left in solution, after the addition of normal solution, is 1 mgm. or 20 mgm., or more. The comparison of the assays with the check is best made by placing the bottles so that they catch the reflected light of a white surface. A shelf with a back to which a sheet of opal glass is secured, and arranged so that it faces the direct light from a window, is very suitable for the purpose. A side light is liable to give rise to error of judgment in comparing the tints.

In addition to the importance of treating all assays under exactly the same conditions, the two most important points to be observed in working the Volhard method are the expulsion of all nitrous fumes and the thorough mixing of the liquid after the addition of the normal and deci-normal solutions. The complete expulsion of nitrous acid is very necessary for accurate work, as the color of ferric thiocyanate is destroyed by this acid at common temperatures. It is not advisable to allow the assays to stand for any long period after the addition of the normal solution, as the color of ferric thiocyanate is slowly affected by light.

In dealing with a large number of assays it is convenient to work them in batches of fifteen or twenty, according to the capacity of the mechanical shaking machine, and experience has shown that it is desirable, after adding the 100 cc. of normal solution, at once to shake each bottle by hand for a short time to mix the contents instead of allowing them to stand unmixed until the whole batch is ready for the shaking machine.

Although the Volhard method, on account of the poisonous nature and extra cost of thiocyanate, is not likely to supersede the Gay-Lussac method for commercial silver bullion assays, its greater accuracy and the facility with which the assays can be finished make it very suitable for offices in which the assay must be made with the highest attainable accuracy, and in cases where comparative tests only have to be made.

THE ELECTRON THEORY IN RELATION TO ELECTROLYSIS.

The presence of Mr. E. E. FOURNIER-D'ALIE, as author of a paper upon "The Application of the Electron Theory to Electrolysis" (abstracted on page 52 of our February issue.—Ed.), brought several members from the country to the Faraday Society's meeting on Jan. 15. Sir Joseph Swan presided. The author enhanced the interest in the paper which he read by the able illustrative digressions made upon section after section. Sir Joseph Swan well expressed the sentiment of the meeting by regretting that a phonographic record had not been taken of the author's interpolated comments. The written words remained, while spoken words were often forgotten.

A breezy discussion was opened by Mr. J. G. A. Rhodin, who bluntly declared that the application of the electron theory to electrolysis was uncalled for, and would complicate a simple question. Why should they define a disturbing element which they could not see? He did not see the need either for a metaphysical chemistry or for chemical metaphysics. But as to the electron theory, its forerunner was Newton's theory of light corpuscles emitted from a luminous body.

In place of advancing theories, it would be better to spend more time tabulating what was known about the phenomena of solutions. The ions were too excessive a strain on our credulity—why seek to make these more complicated and enshroud the precision of chemical science in the intangibilities of an Athanasian creed?

Dr. Borns inquired what the author thought of the electron theory as a whole. It was fitly regarded as an extension of the ionic theory, but he was afraid that the paper as written was a series of disjointed facts, not well interwoven. The author's explanation of mobility was difficult to follow. Also, why should it require more energy to evaporate a charged drop than an uncharged drop. Was not the electron theory rather under a cloud? Were not positive and negative electrons necessary for the Hall effect? (The author, "No"). Kaufmann's latest experiments seemed damaging to the electron theory.

Dr. Harker said that very few people had time to read elaborate books on this subject, but he must ask the author, was it his conception that was composed of a cluster of electrons, or was it the atom, a sort of solar system? Upon what did stability depend? Was the hydrogen atom, for instance, a huge mass of something with a few electrons hanging on the outside? How did mathematicians regard the electron theory? Were they to pin their faith to it, and fit their figures in around it? More Euclidean definitions were required at the start. Unhappily mathematicians wrote mainly for mathematicians. What non-mathematicians wanted was to know in simple terms the fundamental conception of the theory.

Dr. Lowry asked where the author derived his figures for the density of electrons and their diameter, also for the mean time, during which the electrons were unattached. Electrolytes have positive temperature coefficients of conductivity, but at higher temperatures these become negative. Large ions behaved as spheres moving in a viscous medium, their mobilities did not attain a definite minimum as stated, but additional viscosity in the lower values was simply the viscosity of the additional water.

Mr. Wilsmore thought that the author's explanation would lead to the clearing up of a number of obscure points in electrochemistry. Under ultra-violet light, elements tend to give off negative electrons; there was no evidence of positive electrons apart from matter. If positive electrons were entirely omitted from electrolytic equations the latter were greatly simplified. He suggested the term "negatron" in place of negative electron. Conductivity in electrolytes was probably due to negatrons. It might perhaps be that chemists rushed in where physicists feared to tread. The conception of the negative electron renders simpler the phenomena of oxidation and reduction. Mr. Wilsmore then twice covered the blackboard with the formulæ expressing chemical reactions, in the negative electrons had assigned values. A slight and reciprocally sarcastic breeze followed between the speaker and Mr. Rhodin, who intervened with comments on one of the equations.

Mr. Kaye brought the discussion back to the paper itself by asking whether different ionic mobilities did not involve different states of hydrations? He also asked whether during ebullition any movement in the electrons was assumed to take place.

In reply, the author dissented strongly from Mr. Rhodin's criticism, and declared there was the same reason for attributing mass and weight to the planet Jupiter as to an electron. He pointed out that Weber, between 1850 and 1860, pronounced an ionic theory of conduction, but this was not the "electron theory," as the carriers were supposed to be positive, and the word "electron" was coined by Dr. Stoney in 1880. Free electrons did not exist in liquids. If they did, simple consideration showed that the conductivity would be superior to that of copper, as the electrons were 100,000 times smaller than atoms. Kaufmann's experiments did not decide for or against the electron theory, but simply discriminated between Lor-

entz's and Abraham's mechanical structure of the electron. As regards the structure of atoms and the succession of atomic weights, the work done in this direction was almost entirely due to Mr. J. J. Thomson, who showed that atomic weights were determined by configurations of stability, and whose book on "Matter and Electricity" should be consulted. Mr. J. J. Thomson had proved that an atom did not entirely consist of electrons, but that it consisted of a positive nucleus which was by far the greater part of the mass. The first determination of the number of free electrons in a metal was made by Schuster, and given in the *Philosophical Magazine* in (he thought) March or April, 1904. The Volta series of metals was confined, not only by observations under ultra-violet light, but also, according to Fuchtbauer, under canal rays. The charge of a liquid did not go off with its vapor, the liquid surface behaving in this matter like a perfect semi-permeable membrane.

With the conclusion of the formal debate, which ended after 10 o'clock, your correspondent left the meeting. But an informal debate was waging keenly, "the sea-green unconvertible" (to misquote Carlyle's epithet), Mr. Rhodin urging the view expressed by the great poet that "Knowledge is of things we see," but, unlike the poet, disinclined to accept any views demanding faith.

NEW INCANDESCENT LAMPS.

On Thursday, Jan. 10, a paper on "New Incandescent Lamps" was read before the Institution of Electrical Engineers, by Mr. J. SWINBURNE (F. R. S.), past president. Of this paper I can only give a brief outline. The author commented on the fact that, since the substitution of a carbon filament for the original expensive platinum, there had been for a long time a period of resignation, and it is only recently that serious efforts have been made to manufacture a lamp having some other material for the filament. The difficulty, of course, was to get a sufficiently high resistance without an inordinate length of wire. The controlling factors were the melting point, the specific resistance, and the possibility of making the filaments in practice.

In the second part of this paper the author reviewed the refractory metals and elements possible in this connection. He considered the processes of manufacture and the limitations these imposed on the materials to be used. Titanium, zirconium and vanadium were among the possibilities. Tantalum, of course, is already in use. Reference was made to its exceptional hardness, a curious property in a ductile material. Osmium and iridium had also been tried practically. Mr. Swinburne was of opinion that the trade would tend towards the manufacture of metal filament lamps. The resulting discussion will be summarized in my next letter, owing to lack of space.

MARKET PRICES.

Prices still remain generally high, with the exception of the artificial depression in pig iron, noted below. Copper sulphate is now at £32.10 per ton. Shellac is moderate at 220/- per cwt, and Para rubber steady at 5½. Copper is still strong at £107, though slightly easier to £106 about the twentieth, owing to determined selling by important dealers. Platinum is quoted at 150/- per ounce, but it is doubtful if much could be obtained at that price. Tin inclined to rise at £192.10. Zinc is rather easier at £31.15 per ton. Lead is slightly lower at £20.2.6. Cleveland warrants, in the face of a good natural demand, have steadily declined throughout January. This is attributed to the large stock held by dealers. The buyers holding off for further reductions have contributed to bring this about.

A situation of this kind will naturally require delicate handling not to result in a sudden sharp rise in prices. The present price of No. 3 is 57/. Steel rails (heavy) are £6.12.6 net f. o. b., and ship rates £7.10.

LONDON, Feb. 6, 1907.

RECENT METALLURGICAL PATENTS

IRON AND STEEL.

Converter Plant.—The molten pig iron, tapped from the blast furnace, is brought by means of transfer ladles to the steel plant and stored in receivers until it can be treated in the converters or open-hearth furnaces. It is of great importance for continuity of working that the receivers should be always in good order and should be used without opportunity for cleaning or repair for as long periods of time as the steel plant continues in operation. For this purpose it is specially important that such segregations should be avoided in the receivers, as often result from kish and other more or less silicious substances in the pig iron. Mr. H. H. Campbell, the general manager of the Pennsylvania Steel Co. at Steelton, Pa. (843,582, Feb. 12, 1907), has arranged his plant so as to achieve the above object together with saving of time and economy of production in the whole plant. The arrangement is shown in Fig. 1, which is a plan view of a Bessemer steel plant with converters 5 in customary relation to each other, elevated fixed troughs or runners 6 placed behind the con-

from it branches 34 are provided with valves from which one or more nozzles extend through openings into the receivers, so as to direct the blast above the surface of the metal in the receiver. Mr. Campbell has found that in this way he is enabled to remove accumulations of kish, congealed metal, or skulls, and other accretions incident to receivers, by a process of combustion or decomposition effected by the oxygen of the air burning out the carbon of the kish and melting the slag and other foreign substances, thus keeping the receiver clear of such obstructions for long periods of time and at the same time increasing the heat of the metal contained in the receiver.

Making Briquettes.—In the manufacture of cellulose or paper pulp under what is known as the "sulphite process" (which consists in boiling wood and other fibers under pressure in a solution containing sulphurous acid and a base, such as lime or magnesia), a vast quantity of a watery mixture known as "waste sulphite liquor" is produced that so far has had little value. J. S. Robeson (841,718, Jan. 22, 1907) pro-

poses to utilize it for making a binding agent for the production of briquettes from ore fines, etc. This liquor is neutralized by means of milk of lime and then quickly concentrated in vacuo without producing decomposition. To this mass of liquor, with a density of about 30° Baume, the same quantity, by volume, of wood-tar is then added. By the term "wood-tar" is meant the heavy liquid residue from the condensed products of the destructive distillation of woody tissues in the manufacture of pyroligneous acid and methyl alcohol, etc. The combined mixture is heated and is then ready for use as a binding agent for making briquettes of ore, etc. In making the briquettes the required quantity of the binding material will depend entirely on the material. For instance, fuel of a bituminous character will require a smaller proportion of the binder than iron ore. For making iron ore briquettes a mixture of 97.5 per cent iron ore with 2.5 per cent of the binding agent is made. The briquettes after they have left the shaping press are subjected to a temperature not less than 500° F., whereby the briquettes are hardened and at the same time one-half of the sulphur content of the binder is driven off. As a special advantage of the binding material it is stated that the product is absolutely non-hygroscopic.

Converter Process.—In the Bessemer process the object is generally to burn off first silicon and then carbon. On account of the very large oxidation heat of silicon the temperature increases rapidly, and it has been found that if it rises above a certain critical point the oxygen of the blast prefers to burn the carbon rather than the silicon in the steel. Moreover, from the oxidation of silicon no evolution of gas results, except the nitrogen from the air in the blast, and at the high temperature this nitrogen appears to have a deleterious action on the steel (compare, for instance, page 51 of our February issue). Reactions of this sort cause the production of poor steel, often with a high content of silicon. Mr. Byron E. Eldred (843,592, Feb. 12, 1907) endeavors to hold the temperature down below the critical point by not using a pure air blast but mixing the air in the blast with carbon dioxide from the waste gases of some other furnace. By regulating the amount of air and of carbon dioxide the temperature within the converter may be easily regulated. Concerning the effect of carbon dioxide it is said that it is split up, and its constituents enter into other combinations by reactions which are endothermic in character, so as to produce a distinct cooling

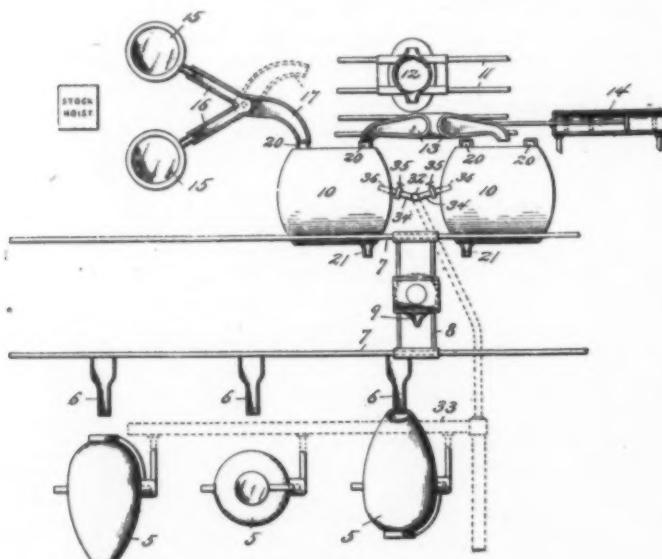


FIG. 1.—ARRANGEMENT OF CONVERTER PLANT.

verters and under an elevated runway 7 of a traveling crane 8, that carries a charging ladle 9, by means of which molten iron is delivered to the converters. Adjacent this runway 7 are mounted one or more receivers 10, two being shown, and in close proximity to them is the track 11, on which runs the transfer ladle car 12, that moves the molten metal from the blast furnace into the steel plant, the metal being discharged into the receivers by the aid of longitudinally-movable receivers runners 13 properly placed for the purpose. These runners are moved by a hydraulic or air cylinder and piston 14, so that metal can be discharged from the transfer ladle 12 into either one of the receivers without changing the position of the ladle car 12 on its track 11. The cupolas 15 are placed near the receivers and provided with fixed runners 16 uniting at their ends and discharging into a cupola receiver runner 17, that is mounted to be swung out of the way when not required, thereby enabling the contents of the cupolas 15 to be run into the receiver 10. The receivers are so mounted that they can be tipped to pour part of the metal contents into the charging ladle 9 through the pouring spout 21; 33 are the blast mains for supplying air to the Bessemer converters 5. From these blast mains 33 a blast pipe 32 receives a strong blast, and

effect. The inventor further states: "The carbon dioxide or the products of combustion appear to have a catalytic action, resulting in an acceleration of oxidation of the silicon, carbon, sulphur, etc., and thereby enabling a 'blow' to be made in a much shorter time than that required in ordinary practice. By my process there is from this standpoint, at least, no limit to the rapidity of the blasting, and I am therefore enabled to use converters of larger dimensions than those heretofore employed." As the chief result he states that by his process he is enabled to make in the Bessemer converter steel resembling open-hearth steel, and able to compete with it; this would considerably extend the applicability of the Bessemer process.

FINE ORES.

Treatment of Fine Ores—A new process of Ferdinand Heberlein (844,355, Feb. 19, 1907) relates to the treatment of fine manganese or iron ore, burned pyrites, blast furnace flue dust and other metalliferous substances in a pulverulent condition. He mixes the fine manganese or other ore with coal and subjects the mixture after ignition to a blast of compressed air. A rapid development of heat takes place, and a sufficiently high temperature is attained to bring about the fusion and agglomeration of the ore under treatment. The volatilizable substances being, moreover, liberated, concentration of the metallic contents takes place. The process may be conveniently carried out in a tip apparatus, such as is generally used in the Huntington-Heberlein process for roasting sulphides. On the perforated iron saucer at the bottom of the receiver is placed a small quantity of live fuel, and upon this is arranged a thin layer of the mixture of ore and fuel. A gentle air blast is then applied, and, as the process proceeds, is gradually increased, the receiver having in the meantime been filled. The combustion propagates itself from the bottom upward, with the result that the substances become agglomerated, there being left in the receiver at the conclusion of the operation a slagged and porous mass ready for tipping and subsequent treatment. When the subsequent treatment is carried out in a blast furnace, the porous condition and lumpy state of the product facilitates the passage of the air blast and other gases and enables regular and economical working to take place. Where the mixture is devoid of moisture it is advantageous to add a certain quantity of water, which not only tends toward the prevention of flue dust formation, but greatly assists in the regular diffusion of the blast throughout the entire mass and in the production of a homogeneous and uniformly well-slagged porous product. As a rule, ores of the character referred to can be treated without the addition of fluxes, but in some instances it is advantageous to add either lime or silica, according to the precise nature of the ore.

FOUNDRY.

Ferro-Silicon in the Foundry.—One of the difficult problems of foundry practice where miscellaneous castings are made is to economically obtain from one melt in a cupola the proper grades of iron suitable for different classes of castings. Thus the articles may range from castings of many tons weight, usually of thick section, requiring strong iron of close-grained texture, often having high chilling properties, to small objects of a pound or so in weight, frequently of thin sections, which may require to be machined, and therefore must be of softer metal having little or no tendency to chill. The practice of foundrymen in the past has been to vary as best as they could the grade of metal in the cupola itself in different periods of heat, and to so group and time their castings as to utilize to the best advantage the different grades of iron obtained from the cupola in one continuous melting operation. In contradistinction to this method Alexander E. Outerbridge, Jr. (842,906, Feb. 5), endeavors to produce the different grades of iron in the metal in the following way: The general run of iron in the cupola is practically not varied by him, iron being molten of a character capable for the castings of the

lowest grade to be made, which may have close grained texture and high chilling properties. He then taps into a ladle a charge sufficient for a particular casting or group of castings which it is desired to make of softer iron having but little chilling tendency. With the molten metal in the ladle he now combines a definite amount of powdered ferro-silicon (containing 50 per cent of silicon). Hard iron can be modified so as to produce a relatively soft gray iron by the addition of even so little as 1 pound of 50 per cent ferro-silicon to 200 pounds of iron. Within certain limits the desired physical characteristics of the metal can be accurately controlled in correspondence with the percentage of the ferro-silicon thus added. The novel feature of the process is claimed to be that the ferro-silicon is added to the contents of the ladle and not to the cupola.

ZINC.

Distillation Furnace.—A. Desgraz and P. Schmidt (843,872, Feb. 12, 1907) point out that to recover as much zinc as possible from the ore in the distillation furnace, the temperature should not at first be allowed to rise too rapidly, since otherwise a serious loss would ensue through the escape of uncondensed zinc fumes from the condensers. As the distillation progresses the temperature is gradually increased, and just before the end of the process it is rapidly raised to white heat, and then, upon the emptying of the separate muffles, again almost immediately reduced to the initial temperature. During all stages of the operation the temperature should be absolutely uniform throughout the whole furnace. The inventors try to accomplish this end by the use of a furnace with a free flame space with rows of muffles on both sides; in the floor of the combustion chamber several pairs of burners are arranged, each of which is connected with the gas supply pipe by means of a regulating valve to be acted on from outside, while the air introduced in a common heating channel is fed to the pairs of burners by means of openings, the opening of each pair of burners being adjustable from outside. By this means there is obtained throughout the furnace a uniform temperature, which can be regulated in accordance with the requirements of the process.

PRECIOUS METALS.

Roasting Furnace.—There are certain ores carrying precious metals in such combinations that when the ore is roasted a considerable percentage of the gold and silver volatilizes in the form of fumes. To prevent this loss, John E. Greenawalt (839,064 and 839,065, Dec. 18, 1906) uses a longitudinal roasting chamber (with rabbling mechanisms, etc.) with a porous bed on which the ore is roasted. Producer gas for furnishing the heat for roasting is supplied to the roasting chamber at one point while at further points air is introduced at intervals into the chamber. The mixture of air and gas is passed downwards through the roasted material and through the porous bed forming the support for the material by means of suction acting from below. A condensing chamber is provided below the porous hearth, and in it the fumes are condensed. Not only the precious metal values contained in the fumes are recovered, but it is possible to treat the sulphurous fumes for the manufacture of sulphuric acid. The inventor states that "by incorporating a suitable catalytic agent—such as platinized asbestos, ferric oxide, etc.—in the porous bed a considerable proportion of the sulphurous anhydride can be cheaply and economically converted into sulphuric anhydride and thus into sulphuric acid in the condensing chamber."

Chlorination.—Another patent of Mr. John E. Greenawalt (837,560, Dec. 4, 1906) relates to improvements in apparatus for chloridizing ores. Its object is the treatment of ores, when in a heated condition, by use of chlorine gas in such a manner as to prevent a loss resulting from the volatilization of the metallic values. When an ore is roasted with salt, the first chlorine released acts upon the baser elements in the ore, and it is only after free chlorine is released from the ore that the

metals volatilize to any great extent. In carrying out the invention the inventor adds a small amount of salt, generally from 0.5 to 1 per cent to the ore. The construction of his

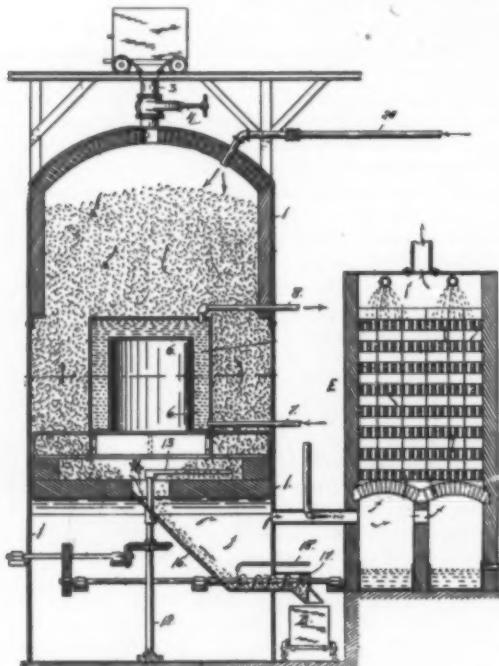


FIG. 2.—CHLORINATION PLANT.

apparatus is shown in Fig. 2. The chloridizing tank consists of an outer shell 1 of sheet steel. The hot ore is brought to the roasting furnace by a car and is discharged into the top

of the chloridizing tank through the pipe 3. The chlorine is introduced through the pipe 20. When the valve 4 in the pipe 3 is closed, the entire upper portion of the tank is gas tight, and a pressure of a few pounds is sufficient under most conditions to cause the gas to permeate the entire ore and percolate downwardly through the ore in the chloridizing chamber. The chlorine gas reacts with a hot ore. But before the inert gases that may be mixed with the chlorine or the surplus can escape from the tank they must percolate through the cooling zone in the lower portion of the tank. The cooling effect is produced by the means of the water-cooled shell 6, cold water entering through 7 and the heated water, together with steam, leaving through 8. In this way the temperature of the volatilized fumes is reduced sufficiently to cause precipitation to a considerable extent. By means of the arm 13 revolving around the shaft 12 the chloridized ore is stirred and discharged into the chute 16, from where it is passed into the screw conveyor 17, in which the ore is moistened with water supplied through the pipe 18, and discharged into the cart B. The gases and steam escaping from the chloridizing chamber are passed into the condensing chamber E, where the remaining values contained in the gases are completely precipitated.

ROASTING FURNACE.

Cooling Devices.—To the long list of patents granted to Mr. Frank Klepetko on details of construction of the McDougall roasting furnace another one has recently been added, its number being 843,825, of Feb. 12, 1907. It refers to the water-cooling devices. Claim 2, which indicates the general character of the construction, reads as follows: "In a furnace having a plurality of hearths, a rotatable hollow shaft passing through the hearths, a series of hollow arms radiating from said shaft and extending into the several hearths, a series of chambers distributed throughout the shaft and communicating with the hollow arms, and a water-feed pipe extending through the several chambers and discharging its water into the same."

SYNOPSIS OF PERIODICAL LITERATURE.

A Summary of Articles Appearing in American and Foreign Periodicals.

ELECTROCHEMISTRY.

Calcium Cyanamide.—The ordinary method of making calcium cyanamide consists in heating finely-ground calcium carbide in an atmosphere of nitrogen. The product contains about 20 per cent of nitrogen, but should be theoretically higher, and apparently only about 70 per cent of the carbide is changed into cyanamide. Since for this reaction a high temperature is required, it is difficult to get an air-tight furnace, as the walls become permeable for gases and oxygen of the air diffuses into the furnace and oxidizes an appreciable amount of the calcium cyanamide, according to the equation $\text{CaCN}_2 + \text{O}_2 = \text{CaO} + \text{CO} + \text{N}_2$. In an article in *Chemiker Zeit*, of Dec. 19, Fredrik Carlson considers this to be the cause of the low efficiency of the old process. He mentions, as other disadvantages high cost of repairs, etc. Polzenius (German patent 163,320) has later devised another process in which the carbide is mixed with 23 per cent of calcium chloride. The advantage is a much lower temperature and almost theoretical efficiency. But the cyanamide produced in this way has certain bad properties, since on account of the addition of calcium chloride the product becomes hygroscopic and the bags in which it is shipped rip. Moreover, nitrogen is lost probably in form of ammonia. For this reason analysis often shows less than 20 per cent nitrogen. The present author, on the

suggestion of his father, has tried whether instead of calcium chloride calcium fluoride could be added, fluorspar being cheap and abundant. The results of tests made in Prof Foerster's laboratory in Dresden were very good, the efficiency being high and the temperature of reaction much less than without the addition. Further, the disadvantages of the cyanamide produced by the Polzenius' method are here entirely absent.

Distillation of Alloys.—Last year, H. Moissan gave an account of extended experiments in which he evaporated in an electric furnace a great many different metals, and after distillation deposited the metallic vapor on a cold mirror. Together with T. Watanabe (*L'Industrie Electrique*, Jan. 25) he has now studied the evaporation of alloys in the electric furnace. If an alloy containing originally equal quantities of silver and copper is evaporated, silver evaporates principally, and the residue will contain almost nothing but copper at the end of 15 minutes after beginning evaporation. If an alloy of silver and tin is treated the same way the silver is evaporated; with an alloy of silver and lead the lead is evaporated.

IRON AND STEEL-

Melting Cast Iron.—Eug. Geilenkirchen, of Hürde, discussed in *Stahl und Eisen* for Jan. 2 and 9, in a paper read before the Verein deutscher Eisenhüttenleute, the use of the

reverberatory furnace in foundries instead of cupolas, particularly in malleable iron works. The cupola will melt pig iron with 10 per cent of its weight of coke, while the reverberatory (sometimes called "air" furnace in America) requires 30 per cent of its weight of soft coal. Since coal is only about two-thirds the price of coke, the 30 per cent costs as much as 20 per cent of coke, making the fuel cost double. For ordinary castings the advantages are all on the side of the cupola, but for high quality castings the conditions are different. The reverberatory permits the close regulation of the composition of the iron, especially as to low carbon and sulphur, the holding of the charge until its composition is known to be right, the furnishing of a large amount of melted metal at one time of uniform composition, and the possibility of melting down of large unbreakable castings. The Siemens regenerative gas furnace is a fine furnace for the iron foundry, although at present used mainly for melting steel. With it any grade of cast iron can be furnished. A very simple form, of only 2 tons capacity, was built for the writer by Heinrich Eckardt, in Berlin, which with generators included cost only 18,000 marks. Acid lining is better for foundry purposes than basic. Such furnaces, if properly built and handled, will furnish two to three charges a day for a year without shutting down for repairs. Such small furnaces will consume, however, 45 to 50 per cent of fuel on the weight of charge melted. Part of this high fuel consumption is due to working only by day; the furnace might be profitably worked at nights also, on melting less particular material, with less attention. The composition found best for castings to be malleableized is: carbon under 3 per cent, silicon 0.4 to 0.8, manganese not over 0.4, phosphorus not over 0.2 at most and if possible under 0.1, sulphur not over 0.1 and if possible under 0.05 per cent.

Determination of Iron.—In the *Mining and Scientific Press* of Dec. 15, 1906, Mr. E. B. Van Arsdale recommends a scheme with which he has had satisfactory experience, and the purpose of which is to perform the reduction of the iron immediately previous to titration, in order to limit the source of error which might be introduced on account of the oxidation of the solution after reduction and before titration. He proceeds by dissolving the precipitated ferric hydrate in one to three hydrochloric acid, and adds 3 or 4 grams of potassium iodide crystals and titrates immediately with sodium thiosulphate solution, using starch indicator. The reaction is then as follows: $\text{Fe}_2\text{Cl}_3 + 2\text{KI} = 2\text{FeCl}_3 + 2\text{KCl} + \text{I}_2$ in the presence of HCl. The free iodine dissolved in potassium iodide is titrated by the thiosulphate according to the usual reaction. The author has found the reaction to be complete in the cold and instantaneous, provided sufficient hydrochloric acid is present. The author states that the starch iodine color will return very soon after the titration is finished, and is due to reoxidation of the iron by the air and the subsequent liberation of iodine. This must be disregarded. The solution from which the iron was precipitated as hydrate must have been sufficiently oxidized by nitric acid, potassium chlorate, bromine water or similar substances in order to ensure complete precipitation. Arsenic, antimony and tin must be eliminated, which can be done easily by a previous precipitation of the iron by ammonium sulphide. Lead will usually have been removed by precipitation, as sulphate and bismuth occurs so rarely that no notice is taken of it in the present instance. The standard of thiosulphate for iron will be to the copper standard as their atomic weights, that is, 56 to 63, as either of them liberates two atoms of iodine.

Literature.—The increased amount of information being published regarding iron and steel is evidenced by the enlargement of our esteemed contemporary *Stahl und Eisen*, the organ of the Verein Deutscher Eisenhüttenleute, from a semi-monthly to a weekly. With its forty pages of reading matter and seventy odd pages of advertisements, weekly, it is a splendid proof of the permanency of the advance of iron and steel.

Meeting of the Verein Deutscher Eisenhüttenleute.—

Stahl und Eisen for January contains the proceedings of the meeting of this society at Dusseldorf in December last. Nearly 1,400 members attended the meeting, and 700 sat down to the *Festmahl* in the Kaisersaal. The joviality of the banquet is attested to by the numerous punctuations of the proceedings by happy speeches received with "Bravo," "Grosse Heiterkeit," "Stürmische Zustimmung," "Allseitiger, lebhafter, langanhaltender Beifall," etc., etc., and ending with the singing of an original poem in honor of Dr. Schrödter and *Stahl und Eisen*. A pleasant feature was the presentation of the Lueg memorial medal to Dr. Schrödter, in commemoration of his twenty-five years service to the society as its secretary and editor of its organ—*Stahl und Eisen*.

GOLD AND SILVER.

Milling Practice with the Lane Mill.—An interesting comparative experiment, in order to try the improvement in the results by introducing a slow-speed grinding mill of the Lane type as an auxiliary to the batteries, is described by Mr. J. A. Stewart in a communication to the *Mining and Scientific Press*, Feb. 2, 1907. The mill consisted of two five-stamp units and treated ore from a rich shoot in the Eureka mine, Whatcom County, Wash. One of the five-stamp batteries was supplemented by the installation of a slow-speed Lane mill, which was to do the fine crushing, the stamps being only used as a secondary crusher. The other five stamps were run the regular way. The Lane mill was 10 feet in diameter, and was placed in front of the battery, which consisted of five 1,000-pound stamps. The intake of the mill was made low enough so that the pulp from the battery could be delivered to it by gravity. The battery was provided with a $\frac{3}{4}$ -inch mesh No. 16 wire screen, and the stamps were dropped 6 inches with a $4\frac{1}{2}$ -inch discharge. The Lane mill was fitted with an 8-mesh wire screen and 6-inch discharge, and the pulp discharged onto plates 5 feet wide and 18 feet long, after which it was sent to two Wilfleys. The other battery of five 1,000-pound stamps, dropped 6 inches with a 5-inch discharge through a 25-mesh wire screen, and the pulp was run over plates 5 feet wide by 20 feet long, and then over one Wilfley. The following saving was shown:

Stamp System.	From Foot of Plates.	Lane System.
51%		65%
80	From the Wilfley Tables.	91
	Screen Test of Tailing.	
90% passed.	30-mesh.	96
70 "	40 "	88
42 "	60 "	66
36 "	80 "	56
14 "	100 "	36
	Screen Test of Concentrate.	
97% passed.	30-mesh.	99
89 "	40 "	96
58 "	60 "	92
51 "	80 "	88
20 "	100 "	80

Mr. Stewart remarks that the product from the stamps when examined by the magnifying glass shows sharp edges and angular shapes, while the reground product has rounded edges and is of globular form. Thus the regrounding process in the Lane mill produces a product which is entirely different from that of the stamps, and in his judgment better for amalgamation. The Lane mill was run at 6 revolutions per minute, and crushed 40 tons per day of 24 hours, whereas the stamps crushed 16 tons with the 25-mesh screen, dropping ninety-six times per minute. The horse-power required for the Lane mill with full load is 12 hp. The author estimates that the cost of repairs will not exceed 3 cents per ton of ore crushed, while the hardness of the ore under treatment is

above the average. By increasing the speed of the mill from 6 to 8 revolutions per minute, he expects a crushing capacity of the mill of at least 50 tons per day.

Filter Practice in Cyanidation.—Commenting upon the article by Mr. E. H. Nutter, mentioned previously in the Synopsis, which dealt with the advantages of the Moore method of filtration, Mr. F. L. Bosqui, *Mining and Scientific Press*, Feb. 2, 1907, calls attention to the advantages of the stationary filter used in the Butters-Cassel process. He thinks that this feature constitutes one of the chief points of merit in the Butters-Cassel process. In order to ensure good work, that is, a uniform deposition and a clear filtrate, the frame must be as nearly as possible straight and true and the canvass must be free from weak places, ripped seams, etc. In the interval between complete deposition and the displacing operation, there is a period of suspension, during which the vacuum is reduced just enough to hold the cake in loose adherence to the canvass, but not enough to dry and crack the cake. Thus, the maintenance of the slime cake in the best condition for displacement by water is a delicate operation which requires careful manipulation. In order to give the best results the filter must not be stretched or strained. The author maintains that it is practically impossible to transfer the filter frames in the Moore process without straining to a greater or less degree the frame and disturb the integrity of the cake. The seams of the canvass are subjected to an alternating tension and relaxation, and they therefore weaken and finally give way, causing leaks and murky filtration. This straining action, therefore, not only interferes in various ways with perfect filtration, but also makes necessary many repairs to the frames. Mr. Bosqui states that the Combination plant at Goldfield, where the Butters-Cassel process is in operation, has run with uninterrupted smoothness from the day of its installation, and the filters have never been taken out for repairs during a service of nearly one year.

Method for Obtaining the Density of Settled Sand.—Various methods are in use for calculating the tonnage of sands contained in settling tanks, but they are liable to inaccuracies of greater or less extent. The following procedure is followed in the plant of the New Goch Gold Mining Co. in the Transvaal, and works satisfactorily according to Mr. D. Simpson, who described it in a recent brief paper before the Chemical, Metallurgical and Mining Society of South Africa. (*Journal Chemical, Metallurgical and Mining Society of South Africa*, August, 1906.) The weight of a known volume of sand is taken by means of a rectangular prism made of stiff sheet iron. Its size is $7\frac{1}{2}$ inches square by 9 inches deep, with a slot the whole width of three of the sides $7\frac{1}{2}$ inches from the top, giving an effective cutical content of about 422 cubic inches. In order to calibrate the instrument it is placed inverted on a sheet of soft rubber and kept in position by means of a bar passed into the slot, the bar being sufficiently curved near the middle so as not to interfere with the surface of the water, which is filled into the box from a graduated vessel up to the slot. The error, due to the rise in level of the rubber surface inside of the prism, has been found to be compensated for by the curved surface of the water above the dry edge of the slot. The apparatus is used as follows: A mass of sand at the desired level is blocked out with set-square, foot-rule and trowel in situ in the tank during its discharge, care being taken that the surface is not trampled upon. Its size is gradually reduced until its sides are about $\frac{1}{4}$ inch longer than the sides of the above-mentioned prism and are at right angles to one another. The prism is then very carefully and gently lowered on to this mass, perpendicularly to its full depth, the small excess of sand at the sides being thus cut off. A thin plate of steel, say, 9 inches wide and 1 foot long, with a knife edge, fitting firmly into the slot, is then gently pressed into the slot until its forward edge rests against the fourth side of the prism. The exposed upper

surface is then leveled off with a flat steel bar. If these operations are conducted with the necessary care, compression of the pulp is said to be entirely obviated. The sample is then lifted bodily in the prism, put into a pen, weighed and dried and from it and from similar samples taken at various positions in the tank the tonnage is calculated as usual. The author has found this the most reliable method he has investigated.

Cyanide Practice on Boulder County (Col.) Ores.—In a paper read before the annual meeting, December, 1906, of the Western Association of Technical Chemists and Metallurgists, Mr. F. Leonard describes the practice at the Cash mill, Magnolia, Col. adopted in the treatment of a telluride gold ore. The ore averages about \$15 of gold per ton. It is crushed in a Dodge crusher and rolls, the product delivered to the finished ore bins being of 6-mesh size. It is then roasted in a cast iron rotary dryer, lined with firebrick, the fuel being crude oil from the Boulder field. The oil is applied with a burner that can be adjusted for the purpose of regulating the blast and controlling the combustion. The ore is introduced by means of an automatic plunger feeder, through a curved 3-inch pipe, the ore being deposited 1 foot from the upper end of the cylinder, which is 16 feet long. The inclination in the whole length of the machine is 10 inches. The ore is passed through continuously, a charge requiring 18 minutes to pass through; it is discharged upon a cooling floor. During this roast the sulphur is reduced from 5 to 8 per cent to five-tenths of 1 per cent. The capacity of the roaster is dependent slightly upon the character of the ore, but it usually is 10 $\frac{1}{2}$ tons per shift of 8 hours, with a consumption of 7 to 8 barrels of crude oil. The roasted ore is spread in thin layers as it is discharged and is allowed to cool. The gold is perfectly free and bright, considerable coarse gold shows when high-grade ore is being treated. An amalgamation process is in course of construction. The cyanide mill is provided with four 15-ton and two 30-ton leaching vats. The vats are charged with hand barrows, and as there often is a quantity of charcoal in the ore, owing to chips from timbers in the mine, the ore is dumped first into about a foot of cyanide solution, say, of .03 per cent strength; this serves the double purpose of acting as a preliminary wash and of floating the carbon, which latter is skimmed off. The solution is drawn off, and in order to complete the washing and to further eliminate the soluble iron salts, due to the roasting, the regular stock solution is run on, covering the charge. This is then drawn off into the weak solution sump until the cyanide strength shows one-half that of the standard solution, which latter stands at 0.5 per cent, or 10 pounds to the ton. It is then run into the standard sump until a strength of 8 pounds per ton is reached, and then it may safely be run through the zinc, as by this time it is very clear and pure. In a 30-ton vat about 8 tons of weak solution are required. When this is drawn off, 7 to 8 tons of the standard solution are required to cover the charge and as much more will be run on before the changes take place, which bring it up to the strength required for entering the boxes. The rate of flow is regulated as circumstances require. In order to avoid contamination of any considerable quantity of the stock solution with the sulphates so abundantly in circulation, the strong solution is pumped from its sump and distributed over the vats that have already started to leach. Just as the solution is ready to be directed through the zinc, the solution in the strong sump is standardized, pumped up and returned to the vat of ore it just passed through, where the sulphates are nicely filtered out and the solution goes through clean. The sulphates are skimmed off. Leaching goes on in the usual way until intermediate sampling shows a satisfactory extraction. The cyanide consumption takes place mostly during the first wash with weak solution, the actual consumption being about 2 pounds per ton of ore treated. The tellurium in the ore does not seem to require any further attention than the roasting process described above, and the author

is led to believe that under certain conditions the slightest roast will suffice.

Tube-Mill Lining.—The question of tube-mill lining has been repeatedly touched upon in these columns, as it is of considerable importance. Records of life have been given from various sources, and the best practice is gradually being evolved. Another record of experiments carried on with various linings at the stamp mill of the Standard Consolidated Co., at Bodie, Cal., is given by Mr. W. W. Bradley in *Mining and Scientific Press*, Jan. 5, 1907. The tailing flow from the mill passes through classifiers and the tube mill regounds the underflow from the latter, and it is also fed with dry tailings from the old slime ponds. The tube mill of the Allis-Chalmers type is about 22 feet long by 5 feet in diameter. The first lining of the mill was made up of special steel plates of about 10 x 12-inch area by 1 inch thick, the base being made in such a manner that the entire lining was interlocking. The plates lasted 4 to 5 months, but some of them would wear unevenly and occasionally one would drop out, which necessitated the stoppage of the mill and the replacement of the loosened plates. The next lining tried was composed of blocks of pine cut from 4 x 6-inch timber into 6-inch lengths. The blocks were slightly wedge-shaped in order to allow for the curvature of the mill, and were set on end. About 36 hours were required to place a new set of these liners, including removal of the old blocks and shoveling the load of pebbles out and in. A set of these liners lasted from ten days to two weeks, and the wooden blocks had the additional disadvantage of producing a soapy mixture with the alkalies present in the cyanide solution. And this saponification was the cause of excessive foaming in the batteries and on the plates of the mill, as well as in the tube mill, the launders and the vats of the cyanide plant. A set of liners made from mountain mahogany lasted a few days longer and the saponification was decreased. After this experiments were made with a quartz lining, which consisted of selected pieces of chalcedonic vein stuff, from the mine, which was very hard and close-grained. The lining was carefully laid with Portland cement and allowed to set for about ten days. In less than one-half hour after starting up the pounding of the pebbles caused the lining to break. The next lining experimented with was of silex, but this did not have as long a life as was expected on account of the uneven wear and the occasional dropping out of blocks. The lining which was then put in was made up of wrought iron bars, 8 inches wide by 1 inch thick, cut in 15 and 7-foot lengths. The length of 15 feet was the longest that could be handled through the man-hole of the tube mill. The bars were put in alternating in order to break the joints lengthwise of the tube mill, and were bolted with countersunk bolts passing through the shell. The liners were all drilled to the same measurements for the bolt-hole, and when the first set was put in, holes were drilled in the tube-mill shell to correspond, so that no further drilling of the shell was required for any subsequent sets. The experience with these liners has been very satisfactory, as they give a life of between three and four months, and are easy to change. The entire operation of shoveling in the load of pebbles, unbolting the old and bolting in the new liners requires only between 20 and 24 hours. The width of the bars, which is 8 inches, as mentioned above, is such that they do not fit closely to the cover of the shell, and on account of this the pebbles have a tendency to turn over on themselves instead of sliding, and this is an advantage, as the sliding action wears out the lining rapidly. The mill with this lining has been grinding from 50 to 75 tons per day. The portion of the stamp mill product which requires regrinding is principally composed of a tough, hard chalcedonic quartz.

COPPER.

Over-Fire in Copper Matting Blast Furnace Practice.—In observing the running of copper smelting furnaces it is frequently noticeable that there is quite a difference in their

behavior from that of lead smelting furnaces, as the latter usually run much more quietly than the former. Frequently in copper blast furnaces there is a good deal of over-fire, and the escaping gases are often highly heated. Mr. L. S. Austin, in *Mining and Scientific Press* of Jan. 5, calls attention to the fact that though this condition of affairs seems to be the usual in copper smelting furnaces, it is not necessarily so. If a silver-lead furnace were to be run in this way a great deal of the lead in the charge would be volatilized and would pass off with the escaping gases. With copper, however, the loss is not very great, though sometimes the blue color of the rising flame gives indication that some such loss actually takes place. However, apart from this, the author is of the opinion that much heat escapes uselessly which should be utilized at the tuyeres, where it is needed to keep the tuyere zone hot. In order to keep down the over-fire as much as possible, the feeding and operation should be attended to properly and the fuel should be also diminished, while the blast should be heated at the same time. In regard to the first desideratum, that is, the proper feeding and operation of the furnace, in the opinion of the author, much more can be done than is generally accomplished by packing the charge, keeping the shaft clear and free from accumulations, feeding large charges properly segregated, keeping the tuyeres open, and feeding fuel so as to come down in front of them. With regard to the heating of the blast, it has been found that hot or even warm blast greatly assists in increasing the heat at the tuyere zone and thus brings the furnace into the best condition. The author states that he has seen copper matting furnaces, and especially those that were devoted to the smelting of roasted leady copper matte, run with but little over-fire, and certainly without the excessive heat which can be observed in the operation of many ordinary copper furnaces. On this account he believes that these conditions need not necessarily exist, and that they can be improved to a greater or less degree.

ALLOYS.

Alloys with Manganese.—S. Wolgodine, in *Revue de Metallurgie* for January, gives the results of systematic examinations of these alloys made in Le Chatelier's laboratory. The fusibility was found as follows:

Percent. Manganese.	Melting Point.	C°.
0	1,085	....
5	1,050	....
10	1,000	....
15	950	....
20	915	....
25	890	....
30	880	....
40	850	....
50	860	895
60	860	1,000
70	865	1,100
80	....	1,140
90	....	1,010
95	....	1,140
100	....	1,275

The study of these figures shows two eutectics, at 40 per cent and 90 per cent manganese, and the existence of the single compound Mn'Cu, at 78 per cent manganese. This compound is also characterized by much greater hardness than any other of these alloys.

Properties of Alloys of Aluminium and Copper.—A large number of tests has been made by H. C. H. Carpenter and C. A. Edwards to ascertain the properties of alloys of aluminium and copper, and the results of their work are embodied in a report to the alloys research committee of the British Institution of Mechanical Engineers. The report is abstracted in the *Iron and Coal Trades Review*, London, Jan. 25. In regard to the preparation of the alloys the authors arrived at the following conclusions: 1. There is no need to melt the alloys rich in

copper in order to obtain thorough mixing, obviate brittleness and secure the best mechanical properties. With due care the first cast is as likely to be as good as any that may follow it. Such differences in properties as have been found are probably to be ascribed to accidental variations in the conditions of preparation, of which probably the most important are variations in the casting temperature and small holes in the castings. This remark, however, does not apply to large castings, in the case of which remelting may always constitute the best practical method of insuring homogeneity. 2. Copper-rich alloys can be perfectly satisfactorily prepared from the pure metals, and no advantage is gained by using the 50 per cent alloy instead of aluminium. The authors have prepared alloys either from the pure metals or from copper and the 50 per cent cent alloy, and the continuity of properties which has been found in the various members of a series constitutes additional evidence that the alloys may be satisfactorily prepared by either method. 3. Alloys rich in aluminium can also be satisfactorily made with only one melting. This remark applies likewise only to small castings, and the authors have found that it is far more important, in order to get the best mechanical properties, to cast these alloys at the right temperature, than to remelt. The authors have ascertained that the limit of industrially serviceable alloys must be placed at 11 per cent of aluminium, and this limit for most industrial purposes might be put at 10 per cent, as beyond this occurs a rapid fall in ductility with no rise of ultimate stress. Between these limits the alloys fall into two classes, namely: 1, those containing from 0 to 7.35 per cent of aluminium, and 2, those containing from 8 to 11 per cent of aluminium. In the first class the material is of apparently low-yield point and moderate ultimate stress, but of very good ductility. The introduction of aluminium causes a gradual increase of strength but hardly affects the ductility. The material is not very sensitive to heat treatment, but is much improved by mechanical work. The second class comprises alloys of relatively low-yield point but good ultimate stress, and from 8 to 10 per cent of aluminium the ductility is also good. Certain alloys in this class are very sensitive to heat treatment. The classification of the alloys into these two chief classes, as regards mechanical tests, was confirmed by microscopical examination. Up to 7.35 per cent of aluminium the alloys consisted of ductile crystals of a solid solution. Heat treatment affects the size of the crystals to some extent, but does not cause profound structural changes as is the case with alloys containing from 9 to 11 per cent of aluminium, its influence on mechanical properties being not far reaching. However, the crystals are much broken up by rolling, and are interlocked into a tougher combination than the cast material. The sudden stiffening of the alloys beyond

8 per cent of aluminium coincides with the appearance of a dark structural constituent, which was found acicular. Brittleness is usually associated with such a structure, the alloy containing 11.73 per cent of aluminium, where the structure is wholly acicular, is only slightly ductile. A further important result of the investigation concerns the corrosion of the alloys in sea and fresh water. The conditions of the tests were made as severe as possible, and the alloys containing from 1 to 10 per cent were found to be practically incorrodible by sea water, whether alone or bolted to a plate of mild steel. The authors, however, call attention to the fact that this result does not necessarily hold true in cases where sea water is exposed to local contamination of particular kinds, for example, town drainage, etc. In the sea water tests the alloys were found to be undoubtedly superior to both Muntz metal and Naval brass, both of which alloys corroded appreciably. The fresh water tests, however, gave an opposite result, as Muntz metal and Naval brass plates were unaffected, while the copper aluminium alloys corroded to some extent. In this investigation cast plates of the aluminium copper alloys and rolled plates of Muntz metal and Naval brass were used. The authors believe that cast specimens are usually more readily attacked by liquids than rolled specimens, and, if this is so, then the conditions of test were severer for the copper aluminium alloys than for the other two. The rich aluminium alloys appear unaffected by such heat treatment as quick or slow cooling. Small chill castings possess superior mechanical properties to sound castings. In order to get the full value of the inherent properties of the alloys, a considerable amount of mechanical work; *i. e.*, rolling or drawing, with or without annealing, should be performed upon them. From 0 to 8 per cent of copper all the alloys roll well, and from 0 to about 4 per cent of copper they draw sound. The tests of sand and chill castings and of the rolled and drawn bars agree in showing that nothing is to be gained by adding more than 4 per cent of copper to aluminium, the introduction of copper causing a fall of ductility and a rise tenacity, which are fairly steady up to 4 per cent. Beyond this there is no increase in tenacity while the ductility continues to diminish. The elastic ratios of the rich aluminium alloys average much higher than those of the rich copper alloys. The variation of properties, caused by the introduction of copper, have been shown in the case of alloys in the form of sheets to be similar to those in the form of rolled and drawn bars, particularly in so far as nothing is gained by adding more than 4 per cent of copper. As far as corrosion is concerned, the rich aluminium alloys showed a behavior exactly opposite to that of the rich copper alloys, inasmuch as they were strongly corroded by sea water but uncorroded by fresh water.

ANALYSIS OF CURRENT ELECTROCHEMICAL PATENTS.

ELECTRIC FURNACES.

Calcium Carbide.—H. L. Hartenstein, 844,018, Feb. 12, 1907.
Application filed April 17, 1905.

The object is to make a high-grade calcium carbide from a cheap raw material, found in many places in the United States and elsewhere, and known as "marl." It occurs in the form of a pulverulent lightly coherent earth or mud, and is ordinarily found in beds in swampy places and comprises about 20 to 50 per cent of water. In this condition it is grayish or grayish-white; when dried it becomes much lighter in color. In spite of the fact that marl is widely distributed and easily obtained its use has hitherto been restricted to the manufacture of Portland cement. The native marl ordinarily contains from 95 to 98 per cent pure calcium carbonate, and on account of this fact the material may be used for the manu-

facture of calcium carbide. The marl is first dried to a certain extent, thoroughly crushed or powdered and then calcined in a suitable rotary calcining furnace at a temperature of about 3,000° F. A certain amount of moisture in the marl is here advantageous since it serves to hold the particles of marl together and prevents them from being blown out of the calcining furnace in the form of dust. Further, the presence of moisture accelerates the expulsion of the carbonic acid from the marl. The moisture is converted into steam, and a current of steam and hot air disintegrates and reduces the calcium carbonate much more quickly (under proper conditions in one-eighth the time) than a current of dry air alone would be able to do. The calcined material consists largely of pure oxide of lime with a small percentage of silica, magnesia and alumina. This hot mass is then mixed with a measured quan-

ity of coke, which has been preheated by the waste gases from the calcining furnace, and the hot mixture is introduced directly into the electric furnace where the calcium carbide is produced. The advantages claimed are that a superior grade of calcium carbide is produced from an inexpensive material; that the expense of disintegration is very much reduced; that all handling and carrying of the material during the various stages of the process is avoided; that the process is made exceedingly rapid, and that care is taken to utilize as much as possible of the heat produced in the calcining stage, so as to reduce the expenditure of electrical energy for the electric furnace operation as much as possible.

Electric Zinc Furnace.—Edward R. Taylor, 843,776 and 843,777, Feb. 12. Application filed May 15 and 27, 1902.

The design of the furnace which serves for the distillation of zinc and other volatile products is shown in Fig. 1 in vertical and horizontal cross-section. The zinc ore, mixed with carbon, and if desired with a suitable flux, is introduced into the furnace through charging openings 22 at the top, and

passes downward around the hood 10 to the lower portion of the furnace. Finely divided retort carbon or coke is introduced into the charging tubes 9, and gravitates over and between the four electrodes 4, filling the space between the retaining walls 7 and also falling between the working faces of the electrodes 4, and there forming a granular bed in which the necessary temperature is developed. This granular bed of carbon between the electrodes constitutes the reaction zone of the furnace. (The graphite electrodes 4 are connected with the outside by means of the metallic conductors 5 and 6. The electrodes are protected on each side by the retaining walls 7.) The hot granular bed of carbon between the

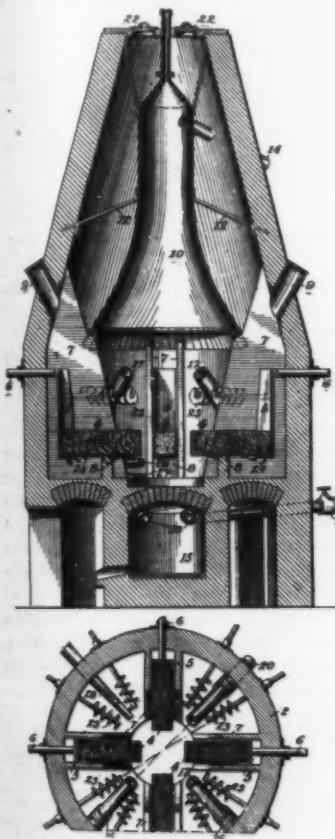


FIG. 1—ZINC FURNACE.

electrodes constitutes the reaction zone of the furnace. The ore adjacent is brought to a temperature sufficient to determine its reduction, and by rotation of the screws 23 and 24 (which are preferably provided in two rows one above the other) fresh quantities of the charge are fed thoroughly into, around and upon the reaction zone, there to be reduced in turn. This feeding may be aided when necessary by stoking. Any slag and non-volatile reduction products collecting beneath the electrodes may be drawn off through tap holes 27 and 28. The gaseous products of reaction, including the gases developed by the reduction of the zinc or other volatile element of the ore, pass upward toward the interior of the bell or hood, and may leave the furnace by either of the following two ways:

either through tubes 17 and 18 (which are rectangular to each other), and discharge into the condenser 15, which is connected with the outside through the tube 29, or they may pass upwards into the hood and discharge through the tube 14. By partially closing valves the gases can be forced either into one or the other way. The heavier constituents as the zinc will tend to pass through the conduits 17 and 18, in which the condenser 15, while the fixed gases or a portion of them escape through the outlet 14. From the condenser 15 the pipe 29 extends outward and upward, and serves to conduct from the chamber any uncondensed vapors. The principal object of this design is to obviate as much as possible loss of heat by radiation from the furnace walls and to prevent the corrosive action of the products upon the fixed elements of the furnace. Patent 843,776 refers to the furnace, 843,777 to the process.

ELECTROLYTIC PROCESSES.

Electrolytic Refining of Metals.—A. Schwarz, 842,254, Jan. 29. Application filed Feb. 6, 1904.

The object is to electrolytically refine metallic concentrates without any previous smelting of the concentrates into matte. The concentrates are compressed by any suitable means into solid masses or cakes of a form or size, so as to be inserted in a suitable framework somewhat after the manner of the plates for storage batteries. The framework may be of wood and covered with a conducting material. As an example the treatment of chalcopyrite ore is given. The ore is crushed and concentrated, and the concentrates are compressed into a frame as described and used as anodes in the electrolytic tank containing copper sulphate with an excess of sulphuric acid. The copper is then deposited on cathodes with a current density of 3 to 5 amps. per square foot. The iron contained in the concentration goes into solution in the form of a sulphate, and after all the copper has been dissolved and deposited the solution is treated for the separation and recovery of the iron in the form of an oxide and the sulphuric acid. The slimes are treated for the recovery of any gold, silver, antimony, etc.

Electrolytic Detinning.—Meredith Leitch, 843,616, Feb. 12, 1907. Application filed July 5, 1906, assigned to American Can Co.

The tin scrap which forms the anode is placed within a perforated iron basket, the outside of which as well as portions of the inside are enameled. Other portions of the inner surface are left unenameled, so that the scrap may make contact with the basket. The object of the application of the vitreous enamel is to make the outside surface of the basket inert; if this is not done it will act as anode and oxygen will be developed. By enameling it the number of ampere-hours required to detin a certain amount of scrap will therefore be reduced. In order to also reduce the voltage of operation the inventor endeavors to diminish the resistance of the cell by increasing the surface of the cathode, using either a corrugated plate or a plate in form of a comb. A form of apparatus suitable for use in a continuous detinning operation is shown in vertical and hori-

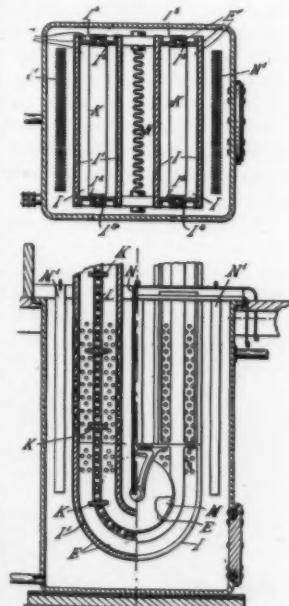


FIG. 2.—DETTINING APPARATUS.

zontal cross-section in Fig. 2. I is a stationary basket through which a conveyor runs, consisting of bars K carried by chains L. The outside of the basket I is covered with the insulating enamel E. The inner surface of the sides I' (made of sheet iron) is also covered with the vitrified enamel E, while the inner surface of the ends I" of cast iron is left uncoated. The chains and the cross bars of the conveyor are also left uncoated. Between the legs of the basket I a corrugated electrode N is placed, while on each side of the basket I two comb-formed electrodes N' are placed, all of which are connected to the negative pole.

Coating Lace with Metal.—J. A. Daly, 844,304, Feb. 12. Application filed Oct. 15, 1901.

The object is to electroplate the finest laces and gauzy fabrics with metal of uniform thickness. The lace is stretched on a frame and the fibers are then covered with a thin, even coating of shellac. The shellac is thoroughly dried and serves to stiffen the lace. When dried the surface is covered with an aqueous solution of nitrate of silver and allowed to partially dry, but before the silver nitrate has thoroughly hardened the surface is again painted with an aqueous solution of potassium sulphide. Decomposition results, yielding silver sulphide and potassium nitrate. The lace is now washed in water which removes the soluble potassium nitrate, leaving the lace covered with a coating of silver sulphide, which is a conductor of electricity. This coating of silver sulphide is comparatively inert and will not destroy the fiber of the lace. The lace is then suspended by a number of wires in a plating bath and electroplated for a few minutes to receive a thin preliminary coating. The lace is then immersed in an alkaline bath to neutralize any acid remaining. It is then washed. The lace is then stretched out and brushed over on both sides with a scratch brush to combine the crystalline metal of the deposit more closely together and to the fibers of the lace. A simple metallic connection is now required, only to get the electrodeposit of metal to the desired thickness. When it is desired to retain the lace in flexible condition the first step of coating the lace with shellac is dispensed with and the nitrate of silver is applied directly to the lace.

Electroplating Apparatus.—H. R. Boissier, 843,321, Feb. 5. Application filed Nov. 25, 1905.

The electroplating apparatus consists of a tank with a shaft fixed at a point of its bottom and moveable in a conical path within the tank. On this shaft is fixed the receptacle which contains the articles to be plated. By a simple mechanical mechanism the shaft and the receptacle are put into the desired motion.

Water Purifying Apparatus.—J. McL. Murphy, 844,167, Feb. 12. Application filed Oct. 6, 1906.

Like in various other water purifying apparatus, the one described in this patent employs aluminium electrodes. The

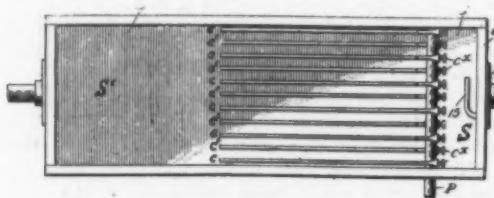


FIG. 3.—WATER PURIFIER.

special object of the construction is to prevent the corrosion of the aluminium electrodes without counteracting their purifying action or the desired formation of the oxyhydrate of aluminium in the menstrum or interfering with the desired carbonic acid formation, due to the intermixing of the anodic oxygen gas with the carbonaceous organic matter in the water. The construction is shown in Fig. 3. B is the feed pipe through which the water enters the space S. It then passes

through long, narrow spaces, each being formed between a positive electrode c and a negative electrode c' into the space S', and then leaves the apparatus. All electrodes are resting in grooves in the bottom of the tank, and are supported by means of hooks on two metal rods, one being connected to the positive pole, the other to the negative pole. By means of set screws c* they are firmly clamped to the rods. The electrodes consist of 95 per cent aluminium and 5 per cent magnesium; the addition of magnesium is stated to prevent undue corrosion of the electrodes. The baffle plate 15 behind the discharge end of the feed pipe serves to distribute the water properly over the whole cross-section of the tank.

Water Purifier.—A. E. Dieterich, 844,262, Feb. 12. Application filed Oct. 3, 1906.

The water first passes through a mechanical filter where those impurities are removed which are in suspension. It then enters an electrolytic purifier intended to precipitate those impurities held in solution. The water finally passes through a second filter which serves to remove those suspended impurities precipitated by the electrolytic purifier. The electrolytic purifier comprises an insulating housing, in which is arranged a pair of aluminium electrodes, so designed and correlatively arranged as to form a zigzag water passage from the inlet to the outlet end. An automatic circuit controller is arranged for the circuit of the electrolytic purifier; by means of this automatic controller the circuit is closed by the water pressure before the water passes into the electrolytic purifier.

PRIMARY BATTERIES.

Primary Battery.—Frank A. Decker, 842,867, Feb. 5, 1907. Application filed July 14, 1906, and 842,945, Feb. 5, 1907. Application filed Feb. 1, 1906. (Two further patents relating to the Decker primary battery, which was already noticed in our Vol. IV, p. 441, and our Vol. V, p. 58.)

Patent 842,867 refers to the construction of the battery "with an auxiliary bottom disposed within an envelope and connected, through the bottom of the envelope, with an exterior member, by means of which a conduit or conduits without the envelope is connected to and communicates with a conduit or conduits within the envelope." The envelopes are of lead, separated by insulating material, while the auxiliary bottom and the exterior member are preferably of hard rubber, vulcanized together through holes in the bottom of the envelope, so that a firm, tight and insulating construction is produced.

Patent 842,945 refers to the construction of a carbon electrode made by moulding and baking or graphitizing, with a corrugated or indented body with borders and transverse ribs reinforcing it. The top of the plate is enlarged either by flanging or gradual thickening.

Battery Receptacle.—H. B. R. L. Poerscke and G. A. Wedekind, 843,549, Feb. 5, 1907. Application filed July 25, 1904.

The patent refers to receptacles for elements made of cast iron, bronze, copper or steel, the walls and partitions of which are so shaped as to afford support to the oxidizing agent, for example, oxide of copper. The first claim reads as follows: "The battery-container electrode, having walls of cast iron bulging outwardly to coöperate with the opposite electrode, a plurality of dovetailed holding projections formed on the inside of said bulging walls and hardened, coherent copper oxide material on said walls engaging said projections forming a substantially flush surface."

Battery Cell.—H. Gernsback, 842,950, Feb. 5, 1907. Application filed June 25, 1906.

The patent refers to a method of assembling a greater number of cells in one group. The inventor spaces the cells apart so as to have an air space between them, in order that there will be no electrical transmission between the cells in case of a defect in the making and also to provide a suitable carrying-handle without needing a carrying-receptacle for the

cells. Between two cells spacing blocks are provided near the top and near the bottom edges of the cells, and between these spacing blocks a rod is inserted which has ends projecting outwards so as to fasten a strap on it on which the cells may be carried.

New Chemical Works.

The F. J. Stokes Machine Co., manufacturers of chemical and pharmaceutical machinery, are now occupying the new plant in Philadelphia which they have built and specially de-



FACTORY OF F. J. STOKES MACHINE CO.

signed for their use. The building is situated on the corner of Seventeenth and Cambria Streets, a short distance from the North Philadelphia station of the Pennsylvania Railroad. The main building measuring 45 x 125 feet, includes a machine shop equipped with a traveling crane of 3-ton capacity, running the entire length of the shop; the front of the building, which is two stories high, being occupied as offices, drafting room and testing laboratory for experimental work in chemical processes, particularly that of vacuum drying, impregnating, etc.

A well-furnished lavatory for employees is situated in the basement in the front of the building, and is equipped with washstands, metal lockers and other conveniences.

The shop equipment consists of the usual lathe, planers, grinders, milling machinery and drill presses necessary for carrying on light and heavy machine work.

Power for operating the shop is supplied by a crude-oil engine of the Hornsby-Akroyd type, built by the De La Vergne Machine Co., of New York City. This also furnishes electric light.

The adjoining illustration shows a general view of the shop, which lacks that characteristic feature associated with older plants of this type—the tall smokestack.

The F. J. Stokes Machine Co. are known throughout the chemical trade of the world as manufacturers of chemical and pharmaceutical apparatus, and have recently taken up the manufacture of vacuum apparatus for drying and impregnating. The modern facilities at their disposal enable the economic construction and erection of heavy apparatus.

Copper and Silver-Lead Ores.—Catalog 6 of the Power & Mining Machinery Co., of Cudahy, Wis., gives an excellent, concise and well-illustrated review of modern methods of roasting, smelting and refining copper and silver-lead ores.

Slime Concentrator.

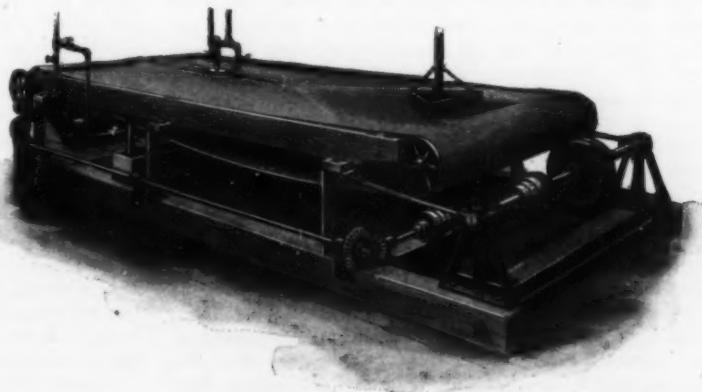
The great need of a slime concentrator that would save the maximum amount of slimes in a concentrating plant, and at the same time be simple in construction and easy of operation, has always been recognized by mill operators, wherever the practice of concentration of ores is carried on. The adjoining illustration shows such a machine and one that is entirely new in the field of slimmers. In its design and construction are embodied features differing widely from anything heretofore introduced in concentrators of this class.

It is the joint invention of Messrs. Randall P. Akins and James P. Evans, both of whom have been for a long time connected with the Colorado Iron Works Co., and are well known as experienced mill builders. For nearly a year past, since the machine assumed its present form, it has been subjected to almost continuous work on all classes of concentrating ores, demonstrating daily its efficiency and superiority beyond peradventure of doubt under varied and actual service conditions.

As will be seen by the illustration, the Akins & Evans slime concentrator is of the traveling belt type, with a longitudinal or endwise shake. It is provided with a roller or drum at each end, also a wash roller and a take-up roller below the deck. These rollers serve the purpose in their respective places of carrying, imparting the travel to, washing, taking up and adjusting the true travel of the belt. These

operating features are in a measure similar to those of a true vanner, but there the similarity with that and other machines ends. The great advantage of the machine lies in the form or contour of its deck, which will readily be understood from an examination of the illustration with the following brief description:

The triangle shown is the pan or depression and the feed and settling space, the forward lines of which are substantially



SLIME CONCENTRATOR.

level; the central line extending from the settling space to the discharge end of the machine is the apex, and is the high line or portion of the deck from which and from the forward lines of feed and settling space the deck slopes forwardly and sidewise to the waste launders on each side. The belt is preferably of canvas or duck surface and of sufficient flexibility that in passing or being "drawn" over the deck it conforms to the contour thereof, maintaining perfectly the form of the pan or depression into which the slime pulp is distributed from the feed box. The water in the pan becomes comparatively quiet and the mineral constantly has an opportunity to settle, aided by the gentle reciprocal end-shake,

and is thus caused to adhere firmly to the surface of the belt.

The pan or depression is so shaped that as the heavy mineral settles, the lighter material is thrown by the motion of the table and gradually drawn by the travel of the belt toward the discharge point of triangular feed and settling space so that the tendency is for the lighter material to come on the deck proper at the beginning of the apex, where it is gradually washed toward the sides by a series of jets of water from a longitudinal and horizontal perforated pipe about 20 inches long, placed immediately above the deck at the beginning of the apex.

Following this pipe along the apex there is a similar one extending to the discharge end which supplies wash water to the deck. Two independent wash-water pipes are placed near the two corners at the discharge end, which have an adjustable sweep for further cleaning the concentrates when necessary.

The overflow from the feed and settling space over its level forward edges is uniform and thin, as is also the flow over the sloping sides of the machine with the added wash water, which gives the maximum opportunity to settle any agitated mineral that may be traveling with the gangue toward the waste launders.

The concentrates, as will be premised, are carried over the end of the machine with the travel of the belt, which, passing under the wash roller below the deck in water in the concentrates box, are washed off by the reciprocal motion of the table, aided, if necessary, by jets of water supplied through a perforated pipe playing on the belt as it comes out of the water.

In this way a clean belt is constantly presented as it continuously enters the feed and settling space at the head of the deck.

The mechanical features of the machine are simple, easily assembled and cared for when in operation. The deck or top is supported by six flat oak or hickory legs, 4 inches wide and $\frac{1}{4}$ inch thick at thinnest part. These legs are amply strong, and while supporting the top and preventing any side sway, are sufficiently flexible to allow of an easy reciprocal motion to the top.

The main drive shaft is located at the head or feed end, and is fitted with cranks on each side, from which lead two side rods, which in turn are attached to the deck near supports under the head end and which impart the reciprocal motion or end shake. On the drive shaft are tight and loose pulleys to receive the drive from the mill shaft. The tight pulley is cast heavy and also serves as a balance wheel, giving steadiness to the motion of the table. A four-step cone pulley on this shaft is belted to a similar one on a counter shaft on the supporting frame.

A pair of bevel gears engages and transmits the power from the counter-shaft through the long side shaft to the discharge end of the table, where, by means of cut gears which allow for the motion of the table, it is communicated to the roller at the discharge end by a worm and worm wheel, which in its turn imparts the travel to the concentrator belt, the speed being adjusted by shifting the belt on the cone pulleys. The travel of the belt is approximately 26, 33, 43 and 56 inches, respectively, per minute, as governed by these step-cone pulleys, at a speed of 225 revolutions per minute of the drive shaft.

The drive shaft can be run up to 250 revolutions per minute, however, without disadvantage, and on some ores to advantage.

Ample means are provided for adjusting the belt so that it will run true and also for taking up the stretch.

The wearing parts are few and the belt will last a long time, and with ordinary care the machine cannot get out of order.

The floor space occupied is 7 by 16 feet, or about the same as any standard concentrator, and less than 1 hp. is required for operation.

Notes.

American Electrochemical Society.—The next annual meeting will be held on the 2d, 3d and 4th of May (Thursday, Friday and Saturday of the first week of May) in Philadelphia. The professional sections will be held at the University of Pennsylvania. We understand that the local committee is already very active to make the meeting a notable one and to insure a full success. Not only the present president, Mr. Carl Hering, but the secretary, Mr. S. S. Stadtler, and the treasurer, Mr. P. G. Salom, are Philadelphians. This will be the second general meeting to be held at Philadelphia, the first one being the inaugural meeting, held April 3, 4, 5, 1902, at which the Society was founded.

New Members of American Electrochemical Society.—At the February meeting of the Board of Directors the following gentlemen were elected members of the American Electrochemical Society: S. T. H. Hall, Helena, Mont., and J. Henry Lienau, New York. The names of the following gentlemen will come up for election at the March meeting: R. D. Thomas, Oakmont, Pa.; Chas. H. Kerr, Niagara Falls, N. Y., and E. O. Dillon, Bloomington, Ind.

New York Section American Electrochemical Society.—On the evening of Feb. 26 an extremely interesting section meeting was held, at which Prof. Lucke, of Columbia University, presented an elaborate paper on the comparative cost of electric power from water, oil, gas and steam. The paper elicited a long discussion, in which the remarks of Mr. Stott, of the power plant of the New York Subway, Mr. Herreshoff, of the General Chemical Co., and Dr. Backeland were specially interesting. Mr. M. U. Schoop, of Paris, exhibited some interesting samples of aluminium articles welded by his automatic welding method (our Vol. IV., p. 338).

Philadelphia Section American Electrochemical Society.—The March meeting of the Philadelphia Section was held in Soulas' café, Fifth and Ludlow Streets, preceded, as usually, by an informal dinner.

Electrochemical Development in Kentucky.—It is reported that plans are being formulated for an extensive water-power development on the Cumberland River, near Corbin, Ky.; 20,000 hp. shall be first developed, and most of this is intended to be used in works for the electrolytic production of aluminium. At present the Pittsburg Reduction Co. is the sole producer of aluminium in this country, and is protected in its monopoly until 1909 by the Bradley patent. By that time the new company hopes to be ready for work.

Iron and Steel Institute.—The annual general meeting of the Iron and Steel Institute will be held on May 9 and 10, at the Institution of Civil Engineers in London.

Fire at Niagara.—On the afternoon of Feb. 25, the works of the Acker Process Co., at Niagara Falls, were destroyed by fire. One life was lost, that of Henry S. Fairchilds, an electrician, who was caught under the falling walls. With the collapse of the buildings which, it is understood, are a total loss, several cables from the power houses were torn down. The total loss is estimated at about \$800,000.

The Virginia Electrolytic Co., the formation of which, with offices at 97-103 Cedar Street, New York City, was recently recorded in our columns, has its plant located at Holcomb's Rock, Va. It controls at that point the entire flow of the James River. The electrical installation is now about 1,800 hp., and more is to be installed shortly. The property formerly belonged to the Willson Aluminium Co., which company has a larger plant at Kanawha Falls, W. Va. The new company was created by a separation of interests, including property, processes and patents. It is operated independently of the other plants. The list of products, including ferro-alloys, metallic silicon, sodium, calcium and magnesium, indicates that the company occupies a very interesting and unique field.

Lehigh University.—At the celebration of Washington's Birthday at Lehigh University, South Bethlehem, Pa., the honorary degree of Doctor of Science was conferred on Arthur Arton Hammerschlag, Director of the Carnegie Technical Schools of Pittsburg, Pa. The orator of the day was Hon. W. U. Hensel, of Lancaster, Pa., ex-Attorney-General of Pennsylvania.

Concrete Construction.—At the smoker of the Chemists' Club, of New York City, on Feb. 2, Mr. Richard L. Humphrey lectured on modern concrete construction, with special reference to the San Francisco earthquake.

The Willson Aluminium Co., of New York City, have removed their offices from 99 Cedar Street to 79 Wall Street.

Messrs. Fred. Bertuch & Co., of New York City, have received the order for the stoneware and porcelain supplies to be installed in the new Mint at San Francisco.

The Buffalo Dental Manufacturing Co., of Buffalo, N. Y., has just issued a new edition of their catalogue B of laboratory and workshop appliances (list No. 34, 1907). A comparison of this new catalogue with former editions is evidence of the progressiveness of this concern.

Cupola Linings.—The Harbison-Walker Refractories Co., of Pittsburg, has just issued a small but very suggestive pamphlet, entitled "A Little Talk on Brick for Cupola Linings," which contains much practical and useful information for foundry men. We intend to refer to some interesting points in detail in our next issue.

Carbon Dioxide Recorder.—The business hitherto carried on by Mr. John A. Caldwell, New York, in fuel-saving devices, including the widely known "Ados" CO₂ Recorder, has been merged into the Sarco Fuel Saving & Engineering Co. This company has taken over the American interests of Sanders, Rehders & Co., Ltd., fuel-economy specialties, of London and Manchester, and to manufacture on this side their various apparatus.

Electroquartz.—We have received from Wilson-Maeulen Co., of New York City, some notes on their "electroquartz," a pure silica product of the electric furnace which has all of the properties of the very costly product made from rock crystal except transparency. Fused silica is milky white. Concerning further properties reference may be made to page 67 of our February issue. The Wilson-Maeulen Co. keep in stock pyrometer tubes (closed at one end), tubes (open at both ends), pipes, plates, muffles, crucibles and dishes of fused silica. Another novelty which this company is now placing on the market in this country are Bunsen burners entirely of porcelain. These are the only Bunsen burners that can be easily kept clean.

The Kny-Scherer Co., department of laboratory supplies, 225-233 Fourth Avenue, New York City, is the consolidation of the old Kny-Scherer Co. and the Laboratory & School Supply Co., of New York, and the American representative of the well-known firms of Dr. Peters & Rost and Max Kaehler & Martin's, of Berlin. The company deals in all kinds of chemical apparatus and laboratory supplies and makes a specialty of completely furnishing and equipping laboratories for educational institutions, technical schools, agricultural experiment stations, chemical works and factories. Two catalogues recently issued by the company are extremely handsome and valuable; these are catalogue 54, on apparatus for physiological, pathological, bacteriological and other clinical laboratories, and catalogue 60, on general chemical and scientific apparatus. Supplementary list 61 deals with lecture, physico-chemical and electrochemical apparatus, supplementary list No. 62 with apparatus for practical and agricultural chemistry.

Electrochemistry in Italy.—The Società Italiana di Eletrochimia, of Rome, which was formed several years ago by, among others, the Baden Aniline Works, and by Swiss financiers, holds concessions for the utilization of considerable

water powers in central Italy, including the power of the rivers Tirino and Pescara. The first station in the Pescara Valley is expected to be started in a few weeks from the present time, the plant comprising five generating sets of 2,800 hp. According to the London *Electrical Review* a total of 6,000 hp. has already been contracted for by the Aluminium Co., the Società Prodotti Azotati, and the Società Abruzzere, which have also been constituted with the participation of German capital. It is also proposed to utilize the power of the second and third falls of the Pescara River, which will yield from 22,000 to 29,000 hp. The work for the extension of the factory for the production of electrolytic products is progressing, and will be finished in 1907. As the demand for chlorine manufactures is limited, it is not intended to extend the branch, as was originally contemplated, but to devote attention to other products. The Società Prodotti Azotati has completed its installation for the output of copper sulphate and mineral superphosphate, etc., and the factory for calcium cyanamide is already partly in operation. The Aluminium Co. expects to start its operation during this month, and all branches of manufacture will then be taken up. The share capital of the parent concern of the three companies—the Società Italiana di Eletrochimia—now amounts to \$2,700,000, in addition to \$600,000 in obligations, and the net profits realized in 1905-6 reached \$153,500, as compared with \$155,000 in the preceding year. A dividend at the rate of 6 2-3 per cent has just been declared for 1905-6, being the same rate as was paid for the previous twelve months. According to the *Chemiker Zeitung*, the Società Eletrochimica del Caffro, founded by Asba, Curletti & Zironi, has completed its plant and has started operation on a large scale, making caustic soda by the "Kellner process as modified by Solvay." In an apparatus of their own construction the caustic soda solution is concentrated to 38° to 40° Baume. This solution is sold instead of solid caustic soda, since, especially if the consumer is not very far from the producer, the price is considerably reduced when complete evaporation is unnecessary. The company treats common salt from Sicily, about 20 tons being worked up in 24 hours. The new Società Eletrochimica Mouzene has started the manufacture of barium salts and silicates by a new electrolytic method. The Società Italiana Prodotti Azotati has started its new plant at Bologano, in which not only calcium cyanamide but also sulphuric acid and copper sulphate are made in large quantities.

Ferro-Phosphorus.—In a recent consular report we find a statement of Consul D. W. Harris, of Cardiff, concerning ferro-phosphorus, which is used to make steel roll with a better finish. It was first made by "a Liverpool firm" to supply an American demand, where ferro-phosphorus is used in the basic steel process for enriching the slag. In steel for sheet purposes, particularly tin plates, steel with phosphorus rolls with a better finish. Some rails high in phosphorus have been remarkable for their long life. It has also been found that under certain conditions carbon and phosphorus may replace each other. (For further details see the statement of George G. Blackwell, Sons & Co., the Liverpool firm referred to, on page 249 of our Vol. IV.) In the same note it is stated that "in the way of pig metal there was iron with a 7 per cent element of phosphorus produced at one time in the Thomas furnaces at Seaton Carew, in Durham. It is claimed also by a leading writer that phosphoric pig metal is produced in large quantities from the manganiferous brown ores containing phosphite at Ilseide, in Hanover. Pig iron produced at old Hamden furnace, in Ohio, contained much phosphorus."

Portland Cement Industry.—An event of more than ordinary interest in the manufacture of American Portland cement is the recent formation of the Universal Portland Cement Co., a new subsidiary interest of the United States Steel Corporation, which has taken over the cement departments of the Illinois Steel Co., at South Chicago and Buffington, Ind., and of the Carnegie Steel Co., at Universal, Pa.

The cement plant at Universal, which is being equipped at the present time, will be driven by means of electrical energy transmitted over 8 miles from the Homestead works of the Carnegie Steel Co., where a 4,000-kw. Allis-Chalmers gas-engine-driven electric generating plant is to be installed. Units of this type, aggregating 35,500 kw. in capacity, have been ordered by the Steel Corporation for various of its mills. Of the cement-making machinery now on order for installation at Universal, a line of nine Gates ball mills, supplied by the Allis-Chalmers Co., will be prominent.

Colorado College.—We have received from the Colorado College a pamphlet containing the paper by L. C. Lennox and Chas. N. Cox, Jr., on the fusibility and fluidity of titaniferous silicates, which was published in our issue of December last, under the title "Tests of Titaniferous Slags," and a paper by Vernon T. Brigham, on the design of a low-tension switchboard. These are two theses submitted to the faculty in Colorado College in 1906. This pamphlet forms the first issue of the Engineering Series of the Colorado College Publication.

Messrs. Smith, Emery & Co., chemists and chemical engineers, who, after the complete loss by fire of their former offices in the San Francisco disaster, have been occupying temporary quarters at 1068 Broadway, Oakland, will move into their new building, corner of Howard and Hawthorne Streets, San Francisco. This building has been specially designed and erected for its purpose, and will give first-class office and laboratory facilities.

Personal.

Messrs. Waller & Renaud, consulting chemists, electrochemists and metallurgists, of 159 Front Street, New York, announce that their Mr. Henry Stanley Renaud, B. S., L.L. B., has been admitted to the bar and will conduct in future the legal department of the firm.

Prof. Rutherford, of McGill University, has been appointed to be the successor of Prof. Schuster at the University of Manchester, England.

Dr. JEAN BILLITZER, of the University of Vienna, is traveling through this country to study large-scale electrochemical developments.

Digest of U. S. Patents.

Compiled by Byrnes & Townsend, Patent Lawyers, National Union Building, Washington, D. C.

CARBORUNDUM (Concluded.)

No. 527,826, Oct. 23, 1894. E. G. Acheson, of Monongahela City, Pa.

Electric-arc pencils, consisting of finely pulverized carbon 90 per cent, silicon carbide 10 per cent, and tar, compressed, baked and coated in the usual manner. Or the rod may consist of a tube of carbon filled with silicon carbide with or without a binder. Incandescent filaments may be coated with silicon carbide, by suspending the finely powdered carbide in the oil bath used for treating and building up filaments, the amount of carbide deposited being governed by the amount in suspension. The silicon carbide is said to be valuable not only on account of its infusibility and inertness toward oxygen, but by producing a greater number of light-waves for the same energy than other illuminating bodies.

No. 564,219, July 21, 1896. F. E. Parks, of Homestead, Pa.

Adds to molten steel, at or after the end of the refining operation, a relatively small amount of silicon carbide. The carbide, in the proportion of from 6 to 8 ounces per ton of steel, may be enclosed in a small packet and thrown into the mold while the ingot is being poured. Silicon carbide thus added in the mold to "dead soft steel in hot and wild condi-

tion, tapped from an open-hearth furnace," quiets the steel and produces an ingot having a solid top, practically free from sponginess or piping. The carbide may be added to steel in the ladle, at the end of the refining operation, though its addition in the mold is preferable. Manganese and other usual agents may be added with the silicon carbide.

No. 585,036, June 22, 1897. A. E. Hunt, of Pittsburg, Pa.

Adds to molten steel a small quantity of silicon carbide, for example, 5 pounds of carbide to 3,000 pounds of steel. The carbide may be placed in a paper envelope and added to the steel in the ladle, before, with, or after the usual addition of ferromanganese, or, for large ingots or castings, it may be added to the molten steel as it is poured into the mold. It may also be added to the bath of metal in a Bessemer converter, increasing, by its oxidation, the heat and fluid of the metal. Silicon carbide added to ingots of soft steel increases the percentage of carbon and thereby the tensile strength, adds silicon, a portion only of the silicon being oxidized, and quiets the metal, the casting being sounder and more perfect, its surfaces solidifying more quickly, thus diminishing oxidation of the iron by the action of air on the boiling metal, reducing the amount of "crop" to be removed from the top of the ingot after rolling or forging, and permitting the ingot to be stripped from the mold more quickly and in a hotter condition. Silicon carbide is an efficient substitute for ferrosilicon as a means for adding silicon, and is preferable as practically free from phosphorous. It does not lower the melting point of iron or steel, though it readily gives up its silicon and carbon to the metal. It may be used with ferromanganese, decreasing the required amount of the latter. It has a softening effect when added to cast iron.

No. 615,648, Dec. 6, 1898. E. G. Acheson, of Buffalo, N. Y.

Produces wheels, bricks, blocks and crucibles of carborundum by moistening crystalline carborundum in grains of the desired size with a solution, preferably saturated, of sulfate of iron, molding under pressure and firing in a kiln. The iron sulfate is thereby decomposed and the iron peroxid reacts on the silicon carbide to produce an iron silicate binder. For the production of very strong articles, iron peroxid, in powdered form, or ores or clay rich in iron oxid, are mixed with the carborundum crystals. Iron and its compounds do not form a satisfactory bond for amorphous carborundum. A small amount of crystalline carborundum, say from 2 to 10 per cent, is therefore added to amorphous carborundum, in order to bond it with iron sulfate or oxid.

No. 628,288, July 4, 1899. Benjamin Talbot, of Pencoid, Pa.

Employs silicon carbide, either crystalline or amorphous, for the production of firebrick, linings for furnaces and converters, crucibles, molds and other purposes employing high temperatures and destructive slags. The carbide is preferably ground, mixed with tar, molasses, pitch or rosin, or with caustic lime or magnesia, or plastic clay and water. It may be molded into bricks and fired, or merely placed in a metallurgical structure and there dried and burned. The carbide should be free from silica to prevent fluxing by basic slag, but may contain graphite. The nature of the binder is determined by the slag to which the material will be subjected. Linings may be repaired by applying the pulverized dry or moistened carbide.

No. 650,040, May 22, 1900. E. W. Engels, of Essen, Germany.

Renders bricks, plates and other materials fire and acid-proof by coating them with a carbide, especially carborundum. The carborundum may be applied to the brick and fused and united therewith by an electric arc of 200 amps. at 110 volts. Or a mixture of sand and charcoal may be applied to the surfaces of the bricks and subjected to an electric arc of sufficient intensity to produce carborundum therefrom and cause it to unite with the material of the bricks. The bricks may be of any usual material, for example, silicious or clayey substances.

NEW BOOKS.

THE MANUFACTURE OF METALLIC ARTICLES ELECTROLYTICALLY.—ELECTRO-ENGRAVING. By Dr. W. Pfanhauser. Authorized English translation by Joseph W. Richards, M. A., A. C. Ph. D., professor of metallurgy at Lehigh University. 172 pages, 100 illustrations and many tables. Price, \$1.25 net. Easton, Pa.: The Chemical Publishing Co.

LEHRBUCH DER ELEKTROCHEMIE.—By Max Le Blanc. Fourth edition, 319 pages, 25 illustrations. Price, bound, marks 7; in New York, \$2.35. Leipzig: Oskar Leiner.

THE ELECTROLYTIC DISSOCIATION THEORY.—By Prof. R. Abegg, Ph. D. Translated by Carl L. von Ende, Ph. D. 189 pages. Price, \$1.25 net. New York: John Wiley & Sons.

ELECTROCHEMISTRY.—I. Theoretical Electrochemistry and its Physico-chemical Foundations. By Dr. H. Danneel. Translated from the Sammlung Goeschens by Edmund S. Merriam, Ph. D. 181 pages, 18 figures. Price, \$1.25 net. New York: John Wiley & Sons.

NOTES ON CONSTRUCTION IN MILD STEEL.—Arranged for the use of junior draftsmen in the architectural and engineering professions, with illustrations from working drawings, diagrams and tables. By Henry Fidler, M. Inst., C. E. 448 pages, 425 illustrations in text. Price, 16s. net; American price, \$5.00 net. London, New York and Boston: Longmans, Green & Co.

ÜBER DAS GLEICHGEWICHT UND DIE ERSTARRUNGSSTRUKTUREN DES SYSTEMS EISEN-KOHLENSTOFF.—By Carl Benedicks. 33 pages, illustrated. Halle, a. S.: Wilhelm Knapp.

ON THE THEORY AND PRACTICE OF ART ENAMELLING UPON METALS.—By H. H. Cunningham, C. B. 188 pages, illustrated American price, \$2.00 net. London: A. Constable & Co. New York: The Macmillan Co.

ANALYSIS, DETECTION AND COMMERCIAL VALUE OF THE RARE METALS.—A treatise on the occurrence and distribution of the rare metals and earths, the methods of determination and their commercial value in the arts and industries with an historical and statistical review of each. By J. Ohly, Ph. D. Third edition. 290 pages. Price, \$3.00 net. Denver, Col.: The Mining Reporter Publishing Co.

GOLD MINING MACHINERY, ITS SELECTION, ARRANGEMENT AND INSTALLATION.—A practical hand-book for the use of mine managers and engineers, including particulars for the preparation of specifications and estimates. By W. H. Tinney. 308 pages, 97 illustrations, mostly in the text. Price, \$5.00 net. New York: Van Nostrand Co.

INORGANIC CHEMISTRY FOR SCHOOLS AND COLLEGES.—By James Lewis Howe, Washington and Lee University. (A second edition of inorganic chemistry according to the periodic law, by F. P. Venable and J. L. Howe.) 422 pages, 70 illustrations in the text. Price, \$3.00 net. Easton, Pa.: Chemical Publishing Co.

INORGANIC QUALITATIVE CHEMICAL ANALYSIS FOR ADVANCED SCHOOLS AND COLLEGES.—By William Stowell Leavenworth, M. Sc., professor of chemistry Olivet College. 160 pages with illustrations and many tables. Price, \$1.50 net. Easton, Pa.: The Chemical Publishing Co.

ALLEN'S COMMERCIAL ORGANIC ANALYSIS.—A treatise on the properties, modes of assaying and proximate analytical examinations of the various organic chemicals and products employed in the arts, manufactures, medicine, etc., with concise methods for the detection and determination of their impurities, adulterations and products of decomposition. By Alfred H. Allen, F. I. C., F. C. S., past president Society of Public Analysis. Vol. II., part III.: Acid Derivatives of Phenols, Aromatic Acids, Resins and Essential Oils. Third Edition, by A. H. Allen and A. R. Tankard. Price \$5.00 net. Philadelphia: P. Blakiston's Son & Co.

COMBUSTION AND SMOKELESS FURNACE.—By Joseph W.

Hays. 104 pages, 15 text illustrations. Price, \$1.50. New York: Hill Publishing Co.

ELECTRIC AND MAGNETIC MEASUREMENTS AND MEASURING INSTRUMENTS.—By Frank W. Roller, M. Am. Inst., E. E. 398 pages, 312 text illustrations. Price, \$3.50 net. New York: McGraw Publishing Co.

CONCRETE FACTORIES.—An illustrated review of the principles of construction of reinforced concrete buildings, including reports of the sub-committee on tests, the United States Geological Survey and the French rules on reinforced concrete. Compiled by Robert W. Lesley. 152 pages, numerous illustrations. Price, \$1.00. Published for *Cement Age* by Bruce & Banning, New York.

CONCRETE AND REINFORCED CONCRETE CONSTRUCTION.—By Homer A. Reid. 884 pages, 715 illustrations in the text. Price, \$5.00 net. New York: The Myron C. Clark Publishing Co.

HANDBOOK OF MATHEMATICS.—For engineers and engineering students. By J. Claudel. Translated and edited by Otis Allen Kenyon. 708 pages. Price, \$3.50. New York: McGraw Publishing Co.

THE ENGINEERING INDEX.—Vol. IV. Five years, 1901-1905. Edited by Henry Harrison Suplee and T. H. Cuntz, in co-operation with Charles Buxton Going. 1,234 pages. Price, \$7.50. New York and London: *The Engineering Magazine*.

BOOK REVIEWS.

GERMAN MONOGRAPHS ON APPLIED ELECTROCHEMISTRY, Vols. XVIII to XXIV. Wilhelm Knapp, Halle.

Vol. 18: *Elektrolytische Verzinkung*. By Sherard Cowper-Coles. Translated into German by Dr. Emil Abel. 8vo, 38 pages. Price, 2 marks; in New York, \$0.70.

This is a short but very practical description of electrolytic zinc plating (galvanizing). Rather disappointing is the fact, however, that the author gives the minimum of information drawn from his own successful experience, and the maximum concerning the more or less unsuccessful attempts of others. We are left with the impression that the author has hardly given his readers "a square deal," although the work is not by any means without value.

Vol. 19: *Die elektrolytische Chloratindustrie*. By John B. C. Kershaw. Translated into German by Dr. Max Huth. 8vo, 124 pages, 39 illustrations. Price, 6 marks; in New York \$2.00.

The author of this satisfactory review of the chlorate industry was concerned with the ordinary chemical production of chlorate for ten years and now adds to that experience a wide knowledge of electrochemical processes. The work is thus more original and valuable than some other of these monographs which consist largely of extracts from patent specifications without intelligent review or criticism. This is a well-written and interesting monograph from beginning to end.

Vols. 20, 21, 22: *Die Elektrolyse geschmolzner Salze*. By Richard Lorenz. I: Verbindungen und Elemente. 8vo, 208 pages, 9 illustrations. Price, 8 marks; in New York, \$2.65. II: Das Gesetz von Faraday, die Ueberführung und Wanderung der Ionen, das Leitvermögen. 8vo, 243 pages, 59 illustrations. Price, 8 marks; in New York, \$2.65. III: Elektromotorische Kräfte. 8vo, 315 pages, 75 illustrations. Price, 10 marks; in New York, \$3.35.

This monumental work deserves a place alongside of Faraday's "Experimental Researches," for in the 765 pages of text, every page of which is carefully and skillfully written, probably more than half is the record of the laboratory work of the author, carried out either alone or in co-operation with his students. Each of the three parts is worthy of a separate review, and would receive it were it not that the mass of new material each contains could scarcely be mentioned, let alone properly appreciated, in the space at our disposal. The style

JUST PUBLISHED

12mo. Cloth 498 Pages Price, \$2.50 Net

**Van Nostrand's
CHEMICAL ANNUAL**

**A Hand-book of Useful Data
for Analytical, Manufacturing and Investigating
Chemists, and Chemical Students**

Based on Biedermann's "Chemiker Kalender"

EDITED BY

Prof. J. C. OLSEN, A.M., Ph. D.

Polytechnic Institute, Brooklyn

Formerly Fellow Johns-Hopkins University

Author of "Quantitative Chemical Analysis, by Gravimetric, Electrolytic,
Volumetric and Gasometric Methods."

With the Co-operation of Eminent Chemists

FIRST YEAR OF ISSUE, 1907

The absence of a comprehensive reference book of numerical data of the Science, has induced the publishers to undertake the publication of this Annual, which it is their intention to issue, with new data added, annually.

IN PRESS

8vo. Cloth About 350 Pages

SOLUBILITIES
OF
Inorganic and Organic Substances

**A Hand-book of the most
Reliable Quantitative Solubility Determinations**

COMPILED BY

ATHERTON SEIDELL, Ph.D. (J.H.U.)

Bureau of Chemistry, U. S. Department of Agriculture

The principal features which have been emphasized in the preparation of this volume are as follows:

**Completeness of Data
Uniformity of Expressing Results
Selection of Most Reliable Determinations
Arrangement of Material**

D. VAN NOSTRAND COMPANY

Publishers and Booksellers

23 Murray and 27 Warren Sts., New York

is clear and interesting, the treatment systematic and complete, and the whole done with such evident command and mastery of every detail of the subject as to render its reading a keen pleasure. We will simply say to our readers that this work is one of the classics of electrochemistry, and should be within hand's reach of every electrochemist.

Vol. 23: *Elektrolytische Alkalichloridzerlegung mit flüssigen Metallkathoden.* By Dr. R. Lucion. 8vo., 204 pages, 181 illustrations. Price, 9 marks; in New York, \$3.00.

There are some brief introductory chapters on the principles of alkali chloride electrolysis with liquid metallic cathodes. But the bulk of the book is simply a list of German, English, French, Belgian and United States patents relating to this subject, with extracts from the patent specifications. 178 pages of the book deal with mercury-cathode processes, 24 pages with processes using a molten cathode (lead). The book contains very little that is novel or original with the author; it gives essentially extracts without critical discussion.

Vol. 24: *Die elektrochemischen Deutschen Reichspatente.* By Dr. P. Ferchland und Dr. P. Rehländer. 8vo., 230 pages, 124 illustrations. Price, 9 marks; in New York, \$3.00.

The first author has compiled the patents on inorganic electrochemistry, the second, those on organic. The chapters taken in order, cover the light metals, alkaline salts and halogen elements, hypochlorite, oxidized salts, alkaline earths, carbides, decomposition of water, ozone, nitrogen compounds, heavy metals, compounds of heavy metals, apparatus, electrodes, diaphragms, furnaces, miscellaneous; anilines, benzines and their intermediate products, para amido phenol, organic dyes and their intermediate products, pharmaceutical products and miscellaneous organic compounds. Some 600 patents in all are noticed, with an average of ten lines to each. This is very brief space in which to give the essentials of a patent, but those which we have examined closely, as tests, seem to be intelligently and skillfully abstracted. A first-class index—is missing.

LEAD SMELTING AND REFINING. Edited by W. R. Ingalls. 8vo., 321 pp., 51 illustrations. Price, \$3. New York and London: *Engineering and Mining Journal.*

This is a reprint of various articles which have appeared in the *Engineering and Mining Journal* and *Transactions of the American Institute of Mining Engineers* during the last three years, classified by the editor of the first-named journal, and we must not omit to say that twelve out of the fifty-two articles reprinted are from Mr. Ingalls' own facile pen.

The subjects are classified under ten parts (*chapters* might have been the more suitable term), treating of lead mining (28 pages), roast-reaction smelting (20 pages), sintering and briquetting (22 pages), blast-furnace smelting (47 pages), lime roasting of galena (102 pages), other smelting methods (14 pages), dust and fume recovery (21 pages), blowers and blowing engines (12 pages), lead refining (27 pages), smelting works and refineries (37 pages). As is seen from this schedule, the lime roasting of galena rightly receives the lion's share of attention, while blast-furnace smelting comes next.

The impression made by the collection, as a whole, is that the information is first hand, intensely practical and indispensably valuable to any one concerned in any way with knowing the present metallurgy of lead. Take Hofman's unsurpassed "Metallurgy of Lead," last edition, add to it this volume, and the sum is the sum total, the last word which has been said, on present methods of lead smelting.

The typography is clean, the binding attractive, but not strong enough; the book deserved to be printed on better paper.

VAN NOSTRAND'S CHEMICAL ANNUAL, 1907. Edited by John C. Olsen, A. M., Ph. D. 12mo., 496 pages. Price, \$2.50. D. Van Nostrand Company, New York.

This is the first issue of an annual intended to make acces-

sible to chemists the chemical data of most use to them, brought up to date. A. F. Seeger contributed tables on "Oils, Fats and Waxes"; E. E. Reid and C. A. F. Kahlbaum on "Physical Constants of Organic Compounds"; A. Rogers and V. J. Chambers a "Review of Literature and New Books of Organic and Industrial Chemistry"; J. L. Morgan a similar review relating to physical chemistry; G. B. Pagram a similar treatment for "Radioactivity," and C. H. Lips a "Review of New German Books." The rest of the contents are by Prof. Olsen. The various chapters are on the physical constants of the elements, calculations of volumetric analyses, calculation of gas analyses, calculation of gravimetric analyses (each accompanied by useful tables and logarithms), physical constants of inorganic and organic compounds (240 pages), specific gravity and vapor tension tables, and thermochemistry. Nearly 60 pages are devoted to a list of important articles and books in chemistry since Jan. 1, 1905.

All the chapters are satisfactorily done except thermochemistry. Here only the constants concerned in the combustion of carbonaceous fuels are given and no other of the various heats of chemical combination, not even the newly determined ones. Further, the heats of combustion are the laboratory values, to liquid water, instead of the practical values to vapor of water.

The work is beautifully printed; the frontispiece is a fine portrait of Ramsay. The intention is expressed in the preface of enlarging the scope of the annual, in future issues, if the demand justifies it. We hope it will.

* * *

THE CHEMISTRY AND TECHNOLOGY OF MIXED PAINTS. By Maximilian Toch, director of the laboratory of Toch Bros., New York City. 166 pages with 60 photomicrographic plates and other illustrations. Price \$3.00 net. New York: D. Van Nostrand Co.

This is the first book ever published on the subject of mixed paints or paints ready for use. The manufacture of mixed paints is essentially American, and it is most fortunate that the author of this first book is probably the foremost authority on paints in this country, being not only a paint manufacturer of highest standing, but a wideawake chemical engineer. Mr. Toch is at present the president of the Chemists' Club of New York.

The general scope of the book is indicated by the statement of the author that "the volume is intended for the student in chemistry who desires to familiarize himself with paint, or the engineer who desires a better knowledge of the subject, or for the paint manufacturer and paint chemist as a work of reference. It is not intended for those who have no previous knowledge or training in the subject."

Mr. Toch's book appears just at the right time in view of the rapidly increasing uses of mixed paints. "One of the railroads of the United States buys at this writing upwards of one million dollars worth of paint material per year, a large share of this being mixed paints, or paint ready for the brush. Nearly all of the large manufacturing industries which use large quantities of paint are gradually altering their methods so that their paint comes to them ready for application. In no case, to the best knowledge of the author, does a single one of these industries prescribe a single pigment reduced with linseed oil for general purposes, for it has been shown that a mixture of several pigments and a filler is superior from the standpoint of lasting quality and ease of application to a mixture of a single strong pigment and the vehicle."

It is very interesting to learn that the structural iron industry, which has reached an enormous development in this country, uses paints ready mixed with the one exception of red lead, which, in the old prescription of 33 pounds of red lead to 1 gallon of oil, cannot be prepared ready for the brush.

The manufacture of agricultural implements, wagons and wire screens can be cited as industries in which manufacturers have within a very few years adopted the use of ready-mixed

Volume II, Part III, NOW READY

ALLEN'S Commercial Organic Analysis

A TREATISE ON THE PROPERTIES, MODES OF ASSAYING, AND PROXIMATE ANALYTICAL EXAMINATION OF THE VARIOUS ORGANIC CHEMICALS AND PRODUCTS EMPLOYED IN THE ARTS, MANUFACTURES, MEDICINE, ETC. WITH CONCISE METHODS FOR THE DETECTION AND DETERMINATION OF THEIR IMPURITIES, ADULTERATIONS, AND PRODUCTS OF DECOMPOSITION.

By ALFRED H. ALLEN, F. I. C., F. C. S.

Past President, Society of Public Analysts; formerly Public Analyst for West Riding of Yorkshire, the City of Sheffield, etc.

Volume II, Part III

Acid Derivatives of Phenols, Aromatic Acids, Resins and Essential Oils

Third Edition

Rewritten and Revised by the Author and
ARNOLD ROWSBY TANKARD, F. C. S.
Member of the Society of Public Analysts

8vo. Cloth, net \$5.00

P. Blakiston's Son & Co., Publishers
1012 Walnut Street, Philadelphia

Handbook of Mathematics

FOR ENGINEERS AND ENGINEERING STUDENTS

By J. CLAUDEL

Translated and Edited from the Seventh French Edition by
OTIS ALLEN KENYON

A complete book on Mathematics

It covers very thoroughly

Every branch from Arithmetic to Calculus

TABLE OF CONTENTS

PART I.—**ARITHMETIC.** I.—Fundamental Operations on Whole Numbers. II.—Properties of Whole Divisors. III.—Fractions and Decimal Numbers. IV.—Powers and Roots. V.—Ratios, Proportions, Progressions. VI.—Diverse Rules. VII.—Logarithms. PART II.—**ALGEBRA.** I.—Of the Four Fundamental Algebraic Operations. II.—Equations of the First Degree. III.—Powers and Roots of the Algebraic Quantities. IV.—Equations of the Second Degree. PART III.—**GEOMETRY.** Plane Geometry. Solid Geometry. Problems in Geometry. PART IV.—**TRIGONOMETRY.** Plane. Spherical Trigonometry. PART V.—**ANALYTICAL GEOMETRY.** PART VI.—**CALCULUS.** I.—Differential Calculus. II.—Integral Calculus. III.—Applications of Integral Calculus.

Cloth, 708 Pages. 422 Illustrations. Price, \$3.50 Net.

Sent anywhere postpaid for the price

Send Us Your Inquiries

Write For Our Catalogs

McGraw Publishing Company

PUBLISHERS, IMPORTERS AND BOOKSELLERS

114 Liberty Street,

New York

JOHN WILEY & SONS

Scientific Publishers

43 and 45 EAST 19th STREET
NEW YORK CITY

NEW BOOKS

The Electrolytic Dissociation Theory

By Prof. R. Abegg, Ph.D., of the University of Breslau. Authorized Translation from the German by Carl L. von Ende, Ph.D., Assistant Professor of Chemistry, State University of Iowa.

12mo. vii + 189 pages Cloth, \$1.25 net.

Electrochemistry

I—Theoretical Electro Chemistry and its Physico-chemical Foundations. By Dr. Heinrich Danneel. Privatdozent of Physical Chemistry and Electrochemistry in the Royal Technical High School of Aachen. Translated from the Sammlung Göschner by Edmund S. Merriam, Ph. D., Associate Professor of Chemistry in Marietta College, Ohio.

12mo, vii + 181 pages, 18 figures. Cloth, \$1.25 net.

Ask for our Catalogues and Circular Matter on Chemical Books

paints for their products. These paints are not brushed on, but are so scientifically made, and the difference between a vehicle and a pigment is so carefully observed, that large pieces of their products are dipped into troughs and the paint allowed to drain. The surface is more evenly coated, and the work done in far less time than would be required were it applied by means of the brush as in former years.

Mr. Toch makes a strong plea for professional honesty and courage on the part of the paint manufacturer, who should not hesitate to state openly the results of his researches even if they will interfere with old prejudices. The paint manufacturer should stand back of his products—irrespective of the prejudice of others—provided his new products be mixtures of materials which time, science and investigation have proven to be superior.

After an introductory chapter on the manufacture of mixed paints there follow five chapters on pigments: white pigments, oxides of lead, red pigments, yellow, blue and green pigments. This is followed by a discussion of inert fillers and extenders (silica, infusorial earth, china clay, kaolin, barium and calcium salts) and of paint vehicles (linseed oil, Chinese wood oil, turpentine, benzine, benzol), with notes on the effect of water in the composition of mixed paints. The book is concluded by two chapters on special paints (floor paints, cement paint, damp-resisting paints, paints for breweries) and on the analysis of mixed paints.

Every page of Mr. Toch's book is evidence that the author gives the results of his own experience. The book thus has a decided personal element in conception and presentation, and is representative of the best tendencies in modern chemical engineering. In view of the great importance of paints for all constructing engineers, the book cannot fail to make many friends.

* * *

RADIOACTIVE TRANSFORMATIONS. By E. Rutherford, D. Sc., etc. Price, \$3.50 net. Charles Scribner's Sons, New York.

While the author in this book, which contains his Silliman lectures, gives some account of the general phenomena of radioactivity, this is only done in so far as is necessary for an understanding of the real object of the work—a study of the transformations which are continuously taking place in radioactive matter. Thus we have chapters on "Radioactive Changes in Thorium," "The Radium Emanation," "Transformation of the Active Deposit Radium," "Origin and Life of the Radium," etc.

One of the most interesting chapters is the last one on the "Physical View of Radioactive Processes." Here Dr. Rutherford considers the various hypotheses used in the study of radioactive phenomena and we are glad to observe that he refers to certain absurd notices about these modern discoveries that are current in some quarters: "It has been incorrectly assumed by some that the study of radioactive phenomena has tended to cast doubt on atomic theories."

The futility of the various systems of philosophy so far as a knowledge of the ultimate reality of things is concerned has been so deeply impressed on the minds of many people that they are prone to consider that philosophical speculation is nothing more than a waste of time. But if the study of philosophy has no other value, at least it impresses on the mind the relativity of knowledge and helps to prevent a hard, mechanical conception of such useful hypotheses as that of Dalton. It in no wise lessens the value of Dalton's hypothesis that we may now find it convenient to liken the atom to an onion, or to suppose that it is a structure built of electron bricks cemented with a mortar of positive electricity. No one supposes that if he could see an atom it would look like an onion any more than it would smell like one, and if, to-morrow, someone observes a new phenomenon which makes it useful to liken an atom to an elephant, it will not involve a "revolution" in scientific thought.

NOTES ON
Electrochemistry

By F. G. WIECHMANN, PH.D.

CLOTH

150 PAGES

PRICE \$2.00 NET

CONTENTS

I.—General Principles	IV.—Electrolytic Dissociation
II.—Electrical Energy	V.—Electro-Analysis
III.—Electrochemistry	VI.—Electrotechnology

"The principal aim kept in view in the preparation of this book has been the giving of a clear and concise presentation of the general principles which underlie electrochemical science.

"Endeavor has been made to meet the needs of students entering upon the study of electrochemistry and of chemists interested in the application of electrical energy to chemical problems.

"Prefacing each chapter is a bibliography of important treatises bearing upon the subject matter discussed in it."

Postpaid on Receipt of Price

Write for Catalogs Send Us Your Inquiries

McGRAW PUBLISHING CO.

Publishers, Importers and Booksellers

114 LIBERTY STREET NEW YORK

